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Vol. 5

Seismic Hazard Characterization of 69 Nuclear Plant Sites East of the Rocky Mountains

Results and Discussion for the Batch 4 Sites

Prepared by D.L. Bernreuter, J.B. Savy, R.W. Mensing, J.C. Chen

Lawrence Livermore National Laboratory

Prepared for
U.S. Nuclear Regulatory Commission

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Abstract

The EUS Seismic Hazard Characterization Project (SHC) is the outgrowth of an earlier study performed as part of the U.S. Nuclear Regulatory Commission's (NRC) Systematic Evaluation Program (SEP). The objectives of the SHC were: (1) to develop a seismic hazard characterization methodology for the region east of the Rocky Mountains (EUS), and (2) the application of the methodology to 69 site locations, some of them with several local soil conditions. The method developed uses expert opinions to obtain the input to the analyses. An important aspect of the elicitation of the expert opinion process was the holding of two feedback meetings with all the experts in order to finalize the methodology and the input data bases. The hazard estimates are reported in terms of peak ground acceleration (PGA) and 5% damping velocity response spectra (PSV).

A total of eight volumes make up this report which contains a thorough description of the methodology, the expert opinion's elicitation process, the input data base as well as a discussion, comparison and summary volume (Volume VI).

Consistent with previous analyses, this study finds that there are large uncertainties associated with the estimates of seismic hazard in the EUS, and it identifies the ground motion modeling as the prime contributor to those uncertainties.

The data bases and software are made available to the NRC and to public uses through the National Energy Software Center (Argonne, Illinois).

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Volume V

List of Tables and Figures

The same format for the tables and figures are used for every site. The following is an exhaustive list of all tables and figures presented in this volume.

The symbol "SN" in the following refers to "Site Number" and the corresponding page numbers are given in the table on page x.

List of Additional Tables and Figures

PAGE REFERENCE OF TABLES AND FIGURES

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Foreword

The impetus for this study came from two unrelated needs of the Nuclear Regulatory Commission (NRC). One stimulus arose from the NRC funded "Seismic Safety Margins Research Programs" (SSMRP). The SSMRP's task of simplified methods needed to have available data and analysis software necessary to compute the seismic hazard at any site located east of the Rocky Mountains which we refer to as the Eastern United States (EUS) in a form suitable for use in probabilistic risk assessment (PRA). The second stimulus was the result of the NRC's discussions with the U.S. Geological Survey (USGS) regarding the USGS's proposed clarification of their past position with respect to the 1886 Charleston earthquake. The USGS clarification was finally issued on November 18, 1982, in a letter to the NRC, which states that:

> "Because the geologic and tectonic features of the Charleston region are similar to those in other regions of the eastern seaboard, we conclude that although there is no recent or historical evidence that other regions have experienced strong earthquakes, the historical record is not, of itself, sufficient ground for ruling out the occurrence in these other regions of strong seismic ground motions similar to those experienced near Charleston in 1886. Although the probability of strong ground motion due to an earthquake in any given year at a particular location in the eastern seaboard may be very low, deterministic and probabilistic evaluations of the seismic hazard should be made for individual sites in the eastern seaboard to establish the seismic engineering parameters for critical facilities."

Anticipation of this letter led the Office of Nuclear Reactor Regulation to jointly fund a project with the Office of Nuclear Regulatory Research. The results were presented in Bernreuter et. al., (1985), and the objectives were:

1. to develop a seismic hazard characterization methodology for the entire region of the United States east of the Rocky Mountains.

2. to apply the methodology to selected sites to assist the NRC staff in their assessment of the implications in the clarification of the USGS position on the Charleston earthquake, and the implications of the occurrence of the recent earthquakes such as that which occurred in New Brunswick, Canada, in 1982.

The methodology used in that 1985 study evolved from two earlier studies that the Lawrence Livermore National Laboratory (LLNL) performed for the NRC. One study, Bernreuter and Minichino (1983), was part of the NRC's Systematic Evaluation Program (SEP) and is simply referred hereafter to as the SEP study. The other study was part of the SSMRP.

At the time (1980-1985), an improved hazard analysis methodology and EUS seismicity and ground motion data set were required for several reasons:

o Although the entire EUS was considered at the time of the SEP study, attention was focused on the areas around the SEP sites--mainly in the

Central United States (CUS) and New England. The zonation of other areas was not performed with the same level of detail.

- o The peer review process, both by our Peer Review Panel and other reviewers, identified some areas of possible improvements in the SEP methodology.

- o Since the SEP zonations were provided by our EUS Seismicity Panel in early 1979, a number of important studies had been completed and several significant EUS earthquakes had occurred which could impact the Panel members' understanding of the seismotectonics of the EUS.

- o Our understanding of the EUS ground motion had improved since the time the SEP study was performed.

By the time our methodology was firmed up, the expert opinions collected and the calculations performed (i.e. by 1985), the Electric Power Research Institute (EPRI) had embarked on a parallel study.

We performed a comparative study, Bernreuter et. al., (1987), to help in understanding the reasons for differences in results between the LLNL and the EPRI studies. The three main differences were found to be: (1) the minimum magnitude value of the earthquakes contributing to the hazard in the EUS, (2) the ground motion attenuation models, and (3) the fact that LLNL accounted for local site characteristics and EPRI did not. Several years passed between the 1985 study and the application of the methodology to all the sites in the EUS. In recognition of the fact that during that time a considerable amount of research in seismotectonics and in the field of strong ground motion prediction, in particular with the development of the so called random vibration or stochastic approach, NRC decided to follow our recommendations and have a final round of feedback with all our experts prior to finalizing the input to the analysis.

In addition, we critically reviewed our methodology which lead to minor improvements and we also provided an extensive account of documentation on the ways the experts interpreted our questionnaires and how they developed their answers. Some of the improvements were necessitated by the recognition of the fact that the results of our study will be used, together with results from other studies such as the EPRI study or the USGS study, to evaluate the relative hazard between the different plant sites in the EUS.

This report includes eight volumes:

Volume I provides an overview of the methodology we developed for this project. It also documents the final makeup of both our Seismicity and Ground Motion Panels, and documents the final input from the members of both panels used in the analysis. Comparisons are made between the new results and previous results.

Volumes II to V provide the results for all the active nuclear power plant sites of the EUS divided into four batches of approximately equal size and of sites roughly located in the four main geographical regions of the EUS (NE, SE, NC and SC). A regional discussion is given in each of Vols. II to V.

Volume VI emphasizes important sensitivity studies, in particular the sensitivity of the results to correction for local site conditions and G-Expert 5's ground motion model. It also contains a summary of the results and provides comparisons between the sites within a common region and for sites between regions.

Volume VII contains unaltered copies of the ten questionnaires used from the beginning of the 1985 study to develop the complete input for this analysis.

After the bulk of the work was completed and draft reports for Vols. I-VII were written, additional funding became available.

Volume VIII contains the hazard result for the 12 sites which were primarily rock sites but which also had some structures founded on shallow soil. These results supplement the results given in Vols. II to V where only the primary soil condition at the site was used.

List of Abbreviations and Symbols

A	Symbol for Seismicity Expert 10 in the figures displaying the results for the S-Experts
ALEAS	Computer code to compute the BE Hazard and the CP Hazard for each seismicity expert
AM	Arithmetic mean
AMHC	Arithmetic mean hazard curve
B	Symbol for Seismicity Expert 11 in the figures displaying the results for the S-Experts
BE	Best estimate
BEHC	Best estimate hazard curve
BEUHS	Best estimate uniform hazard spectrum
BEM	Best estimate map
C	Symbol for Seismicity Expert 12 in the figures displaying the results for the S-Experts
COMAP	Computer code to generate the set of all alternative maps and the discrete probability density of maps
COMB	Computer code to combine BE hazard and CP hazard over all seismicity experts
CP	Constant percentile
CPHC	Constant percentile hazard curve
CPUHS	Constant percentile uniform hazard spectrum
CUS	Central United States, roughly the area bounded in the west by the Rocky Mountains and on the east by the Appalachian Mountains, excluding both mountain systems themselves
CZ	Complementary zone
D	Symbol for Seismicity Expert 13 in the figures displaying the results for the S-Experts
EPRI	Electric Power Research Institute
EUS	Used to denote the general geographical region east of the Rocky Mountains, including the specific region of the Central United States (CUS)

g	Measure of acceleration: 1g = 9.81m/s/s = acceleration of gravity
G-Expert	One of the five experts elicited to select the ground motion models used in the analysis
GM	Ground motion
HC	Hazard curve
I_o	Epicentral intensity of an earthquake relative to the MMI scale
I_s	Site intensity of an earthquake relative to the MMI scale
LB	Lower bound
LLNL	Lawrence Livermore National Laboratory
M	Used generically for any of the many magnitude scales but generally m_b, $m_b(Lg)$, or M_L.
M_L	Local magnitude (Richter magnitude scale)
M_b	True body wave magnitude scale, assumed to be equivalent to $m_b(Lg)$ (see Chung and Bernreuter, 1981)
$m_b(Lg)$	Nuttli's magnitude scale for the Central United States based on the Lg surface waves
M_S	Surface wave magnitude
MMI	Modified Mercalli Intensity
M_o	Lower magnitude of integration. Earthquakes with magnitude lower than M_o are not considered to be contributing to the seismic hazard
NC	North Central; Region 3
NE	North East; Region 1
NRC	Nuclear Regulatory Commission
PGA	Peak ground acceleration
PGV	Peak ground velocity
PRD	Computer code to compute the probability distribution of epicentral distances to the site
PSRV	Pseudo relative velocity spectrum. Also see definition of spectra below

Q Seismic quality factor, which is inversely proportional to the inelastic damping factor.

Q1 Questionnaire 1 - Zonation (I)

Q2 Questionnaire 2 - Seismicity (I)

Q3 Questionnaire 3 - Regional Self Weights (I)

Q4 Questionnaire 4 - Ground Motion Models (I)

Q5 Questionnaire 5 - Feedback on seismicity and zonation (II)

Q6 Questionnaire 6 - Feedback on ground motion models (II)

Q7 Questionnaire 7 - Feedback on zonation (III)

Q8 Questionnaire 8 - Seismicity input documentation

Q9 Questionnaire 9 - Feedback on seismicity (III)

Q10 Questionnaire 10 - Feedback on ground motion models (III)

R Distance metric, generally either the epicentral distance from a recording site to the earthquake or the closest distance between the recording site and the ruptured fault for a particular earthquake.

Region 1 (NE): North East of the United States, includes New England and Eastern Canada

Region 2 (SE): South East United States

Region 3 (NC): North Central United States, includes the Northern Central portions of the United States and Central Canada

Region 4 (SC): Central United States, the Southern Central portions of the United States including Texas and Louisiana

RP Return period, in years.

RV Random vibration. Abbreviation used for a class of ground motion models also called stochastic models.

S Site factor used in the regression analysis for G-Expert 5's GM model: S = 0 for deep soil, S = 1 for rock sites

SC South Central; Region 4

SE South East; Region 2

S-Expert One of the eleven experts who provide the zonations and seismicity models used in the analysis

SEP	Systematic Evaluation Program
SHC	Seismic Hazard Characterization
SHCUS	Seismic Hazard Characterization of the United States
SN	Site Number
Spectra	Specifically in this report: attenuation models for spectral ordinates were for 5% damping for the pseudo-relative velocity spectra in PSRV at five frequencies (25, 10, 5, 2.5, 1 Hz).
SSE	Safe Shutdown Earthquake
SSI	Soil-structure-interaction
SSMRP	Seismic Safety Margins Research Program
UB	Upper bound
UHS	Uniform hazard spectrum (or spectra)
USGS	United States Geological Survey
WUS	The regions in the Western United States where we have strong ground motion data recorded and analyzed

Executive Summary: Volume V

The impetus for this study came from two unrelated needs of the Nuclear Regulatory Commission (NRC). One stimulus arose from the NRC funded "Seismic Safety Margins Research Programs" (SSMRP). The SSMRP's task of simplified methods needed to have available data and analysis software necessary to compute the seismic hazard at any site located in the eastern United States (EUS) in a form suitable for use in probabilistic risk assessment (PRA). The second stimulus was the result of the NRC's discussions with the U.S. Geological Survey (USGS) regarding the USGS's proposed clarification of their past position with respect to the 1886 Charleston earthquake. The USGS clarification was finally issued on November 18, 1982, in a letter to the NRC, which states that:

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In addition, we critically reviewed our methodology which lead to minor improvements and we also provided an extensive account of documentation on the ways the experts interpreted our questionnaires and how they developed their answers. Some of the improvements were necessitated by the recognition of the fact that the results of our study will be used, together with results from other studies such as the EPRI study or the USGS study, to evaluate the relative hazard between the different plant sites in the EUS.

This volume (volume V) is one of eight volumes where the methodology and the results of the analysis are presented. The analysis was performed for a total of 69 different geographic locations. These sites were divided into four groups (batches) of approximately equal size. Volume V presents the results for 17 sites located all across the EUS with the exception of the North East.

The results are presented individually for each site together with comments. The seismic hazard results presented here account for earthquakes of magnitude 5 or above only, and a set of calculations was made to provide an estimate of the seismic hazard created at each of the sites by the earthquakes of magnitude between 3.75 and 5.

In addition, a discussion on uncertainty, comparison between sites, sensitivity to site location and a discussion on the factors influencing the distribution of the contributing zones, is presented in Section 3. The other volumes provide an extensive description of the methodology (Volume I), the results for the other groups of sites (Volume II, III and IV), a summary and some comparisons between sites and groups of sites (Volume VI). A copy of all the questionnaires used in the analysis to develop the input is given in Volume VII, and finally Volume VIII gives the results for the sites at which several soil conditions are found.

1. INTRODUCTION

In this Volume we present the seismic hazard estimates for the 17 sites in Batch 4 listed in Table 1.1 and plotted in Fig. 1.1. The seismic hazard results for the Batch 4 sites are based on:

- o The zonation and seismicity inputs provided by our 11 S-Experts listed in Table 1.2.
- o The ground motion models (peak ground acceleration (PGA) models and 5 percent damped velocity spectral models) provided by our 5 G-Experts listed in Table 1.3.
- o The methodology we developed and described in Vol. I of this report.

The results presented in his report differ from our previous results Bernreuter et al. (1984, 1985, 1987) for the following reasons:

- o We used the final updated input from our S and G-Experts given in Section 3 and Appendix B of Vol. I. As discussed in Vol. I, S-Experts 3,6,7 and 12 provided completely new zonations and seismicity parameters, S-Experts 4,10,11 and 13 modified some of their zones and seismicity parameters, and the G-Experts significantly changed their ground motion models. The seismic zonation maps are reproduced here in Appendix B.
- o The lower bound of integration used in the update analysis was m_b = 5.0, i.e., we only included the contribution from earthquakes with magnitude 5.0 and greater. In our previous reports, Bernreuter et al. (1984, 1985), we used a lower bound of 3.75. This change has a significant impact on the results as discussed in Bernreuter et al. (1987). For every site we present plots which give an indication of how much the earthquakes in the magnitude range 3.75 to 5 would contribute to the seismic hazard.

Corrections for the soil conditions at each site have been included using the approach outlined in Section 3.7 of Vol. I. However, it is important to note that each site is assigned to a single fixed site soil category as listed in Table 1.1. The seismic hazard estimates given in this report are at the free surface. At some sites, various parts of the plant may be founded on different types of soils. For example the main containment building might be founded on rock but other structures might be founded on shallow soil. Thus for these rock sites which have a few structures founded on shallow soil the results presented here should then be corrected for the shallow soil amplification effects as described in Vol. VI before the results given in this report are applied to the structures founded on soil. If all structures are founded on the same soil condition, then no added correction is needed.

Section 2 of this report contains the results for each site and, some site specific discussion. In section 3 of this report we make regional observations and comparisons between sites. In Vol. VI we reach overall conclusions based on the regional results presented in this volume and Vols. II, III and IV.

Volume VIII gives the results for the additional site conditions at Arkansas, Callaway and Duane Arnold. These three sites are treated as rock sites in this volume (Vol. V) but they also contain some structures founded on shallow soil.

TABLE 1.1

SITES AND SOIL CATEGORY USED FOR EACH SITE IN BATCH 4

MAP (1)

	SITE NAME	KEY	SOIL CATEGORY
1.	Arkansas	1	Rock *
2.	Callaway	2	Rock *
3.	Comanche Peak	3	Rock
4.	Cooper	4	Sand-like 1
5.	Crystal River	5	Rock
6.	Duane Arnold	6	Rock *
7.	Fort Calhoun	7	Sand-like 1
8.	Grand Gulf	8	Deep soil
9.	LaCrosse	9	Sand-like 2
10.	Monticello	A	Sand-like 1
11.	Prairie Island	B	Sand-like 2
12.	River Bend	C	Deep soil
13.	South Texas	D	Deep soil
14.	St. Lucie	E	Deep soil
15.	Turkey Point	F	Rock
16.	Waterford	G	Deep soil
17.	Wolf Creek	H	Rock

(1) Key used on Fig. 1.1.

(2) Site categories as given in Table 3.9 of Vol. I and repeated in Table 1.4

(*) Have some structures founded in shallow soil.

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TABLE 1.2

FINAL EUS ZONATION AND SEISMICITY PANEL MEMBERS
(S-Panel)

Professor Gilbert A. Bollinger

Mr. Richard J. Holt

Professor Arch C. Johnston

Dr. Alan L. Kafka

Professor James E. Lawson

Professor L. Tim Long

Professor Otto W. Nuttli

Dr. Paul W. Pomeroy

Dr. J. Carl Stepp

Professor Ronald L. Street

Professor M. Nafi Toksöz

TABLE 1.3

FINAL EUS GROUND MOTION MODEL PANEL MEMBERS
(G-Panel)

Dr. David M. Boore

Dr. Kenneth Campbell

Professor Mihailo Trifunac

Dr. John Anderson

Dr. John Dwyer

TABLE 1.4

DEFINITION OF THE EIGHT SITE CATEGORIES

	CATEGORY	DEPTH
Generic Rock		
(1)	Rock	N/A
Sand Like		
(2) Sand 1	S1	25 to 80 ft.
(3) Sand 2	S2	80 to 180 ft.
(4) Sand 3	S3	180 to 300 ft.
Till-Like		
(5) Till 1	T1	25 to 80 ft.
(6) Till 2	T2	80 to 180 ft.
(7) Till 3	T3	180 to 300 ft.
Deep Soil		
(8)	Deep Soil	N/A

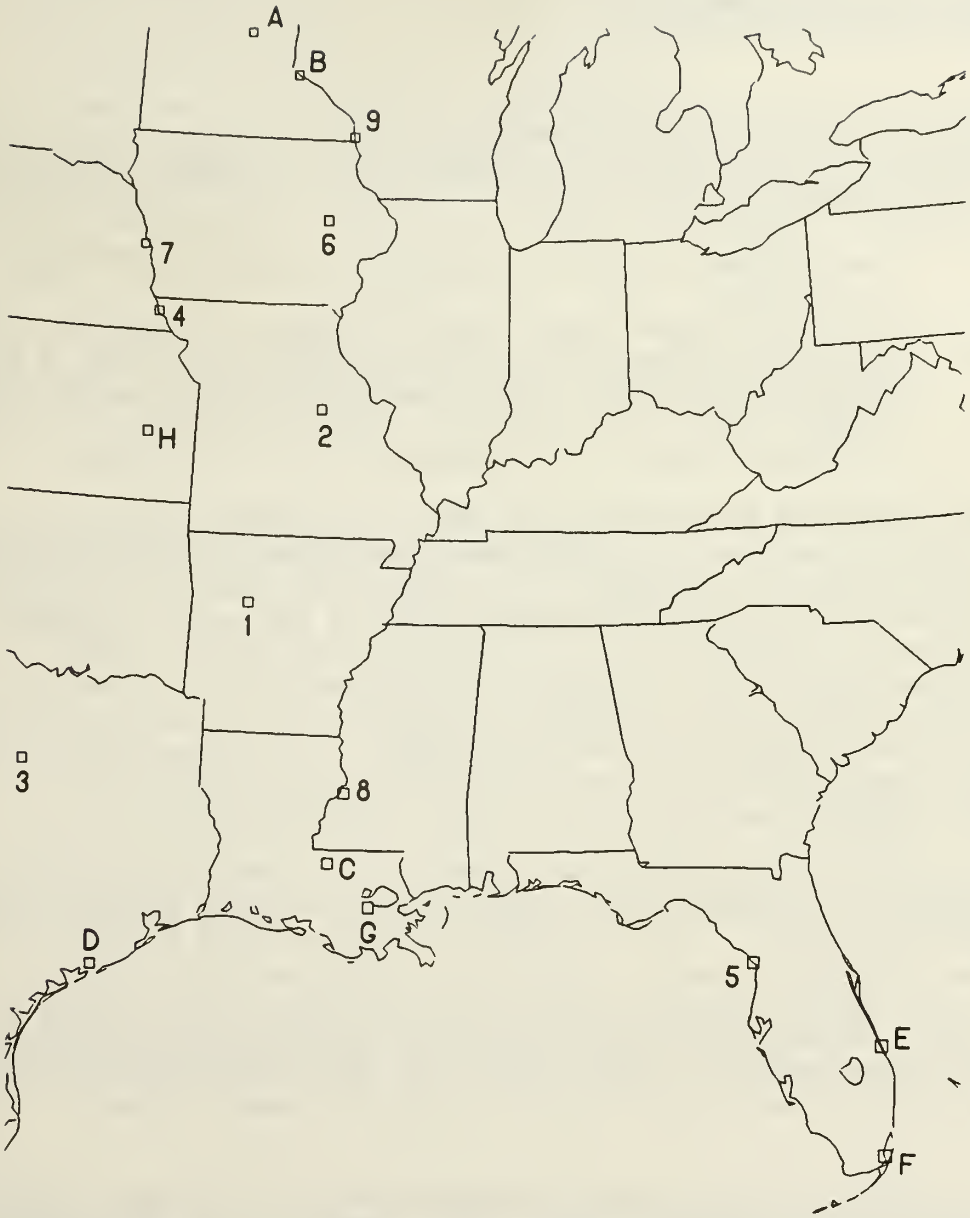

Figure 1.1 Map showing the location of Batch 4 sites contained in Volume V of this report. Map symbols are given in Table 1.1.

2. RESULTS AND SITE SPECIFIC DISCUSSION

2.0 General Introduction

In sections 2.1 to 2.17 we provide the results for the sites listed in Table 1.1. Using a uniform format for each site (i.e. each section) we first present table 2.SN.1 (where "SN" stands for Site Number) providing the following information:

- o Soil category used in the analysis to correct for local site conditions.
- o For each S-Expert table 2.SN.1 provides a listing of the four seismic zones which contribute most to the hazard in terms of the peak ground acceleration (PGA) at both lower PGA (0.125g) and at higher PGA (0.6g) values. The zone ID's listed in the tables are keyed to the S-Experts' maps given in Appendix B of this Volume.

The contribution of various zones given in the table for each site is limited only to the contribution to the best estimate hazard curves (BEHCs). That is, only the zones on the BE map (i.e. those zones which have a probability of existence of 0.5 or greater) and only the BE PGA models are used. This, as is discussed in Section 3.3, is a limitation that should be kept in mind as in a few cases zones with a probability of existence of less than 0.5 which may contribute might not be listed. In addition, the "percent contribution" is not, strictly speaking, a percent since it is the normalized ratio of the hazard contributed by the particular zone to the total hazard, and the rule of hazard addition over all zones is not a linear operation.

The table is followed by ten figures, 2.SN.1 to 2.SN.10 (SN = Site Number given in Table 1.1). The first three figures, Figs. 2.SN.1 - 2.SN.3 give various PGA hazard curves. The next six figures, Figs. 2.SN.4 - 2.SN.9 give various 5 percent damped relative velocity spectra for various return periods. It should be noted that the spectral calculations have only been made at five periods, 0.04s, 0.1s, 0.2s, 0.4s and 1.0s and straight lines have been used to connect these points to get the shapes plotted.

Figures 2.SN.1 give a comparison between the best estimate hazard curve (BEHC) and the arithmetical mean hazard curve (AMHC) for the peak ground acceleration (PGA).

The BEHC and the AMHC are aggregated over all S- and G-Experts and include the experts' self weights. Reference should be made to Section 2 and Appendix C of Vol. 1 for a discussion about these two estimators. Briefly, in our elicitation process we asked each S-Expert to indicate which set of zones he considered his "best estimate" in the sense that it represented the mode of the distribution of all of his choices and similarly for the best estimate

values for all of the seismicity parameters for each zone. We also asked each G-Expert to indicate which ground motion model represented his best estimate model. Then, as indicated in Vol. I, the set of best estimate zones and seismicity parameters are used with each of the best estimate ground motion models to generate 55 BEHCs'. These 55 curves are then aggregated using both the S- and G-Experts' self weights. The AMHC is generated in the usual manner using all 2750 simulations of the Monte Carlo analysis.

Figures 2.SN.2 give the BEHC for each S-Expert aggregated over the five G-Experts. Whenever individual S-Experts' hazard curves are plotted they are denoted by the plot key given in Table 2.0. Figures 2.SN.2 give a measure of the range of difference of opinion between the eleven S-Experts.

Figures 2.SN.3 give the 15th, 50th and 85th constant percentile hazard curves (CPHCs) based on all 2750 simulations and give a measure of the overall uncertainty.

Figures 2.SN.4 give the contribution to the BEHC (aggregated over all S- and G-Experts) for earthquakes in four magnitude ranges:

Curve Number	Magnitude Range
1	$3.75 \le m_b \le 5$
2	$5 \le m_b \le 5.75$
3	$5.75 \le m_b \le 6.5$
4	$6.5 \le m_b$

The curves are useful to indicate the relative contribution of smaller, moderate and large earthquakes to the seismic hazard and how much higher the estimated seismic hazard would be if the contribution of smaller earthquakes in the range 3.75 to 5.0 were included.

Figures 2.SN.5 give the best estimate uniform hazard spectra (BEUHS) for return periods of 500,1000,2000,5000, and 10,000 years, aggregated over all S and G-Experts.

Figures 2.SN.6 give the 1000 year return period BEUHS for each of the S-Experts, aggregated over the G-Experts. The S-Experts' BEUHS are plotted using the symbols in Table 2.0. These plots give a good measure of the significance of the differences in opinion between the S-Experts.

Figures 2.SN.7,8,9 give the 15th, 50th and 85th constant percentile uniform hazard spectra (CPUHS) aggregated over all S and G-Experts for return periods of 500,1000 and 10,000 years. The spread between the 15th and 85th CPUHS gives a good measure of the overall uncertainty in the estimate of the seismic hazard at the site.

Figures 2.SN.10 give the 50th CPUHS for return periods of 500,1000,2000, 5000 and 10,000 years, aggregated over all S and G-Experts.

For some sites, such as the Arkansas site, additional figures (i.e., figures 2.SN.11, 2.SN.12 and 2.SN.13) are given to demonstrate specific points.

A separate discussion is given when some factors of interest are noted. In Section 3 comparisons between the sites and general observations are made.

TABLE 2.0

PLOT SYMBOL KEY USED FOR INDIVIDUAL S-EXPERTS ON FIGS. 2.SN.2 and 2.SN.6

Expert No.	Plot Symbol
1	1
2	2
3	3
4	4
5	5
6	6
7	7
10	A
11	B
12	C
13	D

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2.1 ARKANSAS

Arkansas is a rock site and is represented by the symbol "1" in Fig. 1.1. Table 2.1 and Figs. 2.1.1. to 2.1.10 give the basic results for this site. The AMHC is above the 85th percentile CPHC. Fig. 2.1.3 shows that the distribution of the hazard is not symmetrical. This is due to the fact that the G-expert 5 leads to higher hazard estimates than the rest of the G-experts as shown for S-experts 1 and 4 in Fig. 2.1.11 and 2.1.12. This phenomena is discussed later in this section, and more details are given in Section 2.3 of Vol. VI.

Figure 2.1.4 indicates that most of the hazard is coming from earthquakes greater than $m_b = 6.5$. It also suggests that the hazard curve would only change for PGA values less than 0.10g if earthquakes in the range $3.75 \leq m_b \leq 5$ were to be included.

Table 2.1.1 shows that for 3 out of the 11 S-Experts, the zone which contributes the most to the hazard at 0.125g is the host zone (i.e. the zone within which the site is located). At 0.6g it is for 4 out of 11 S-Experts. For S-Experts 2,4,5,7 and 13 a distant zone (i.e. the New Madrid zone), with generally high recurrence rate and high upper magnitude cutoff dominates at low and at high PGA. In the case of S-Expert 1, the dominant zone at low PGA is the host zone (i.e. zone 5) and at high PGA it is the distant New Madrid zone. For all S-Experts, the New Madrid zone is a significant contributor to the hazard for the Arkansas site.

The BEHC are aggregated over the G-Experts (Per S-Expert) arithmetically so that a high outlier tends to dominate the results. G-Expert 5's ground motion model leads to BEHCs that are high outliers (relative to the other G-Experts' BEHCs per S-Expert) at the Arkansas site. G-Expert 5's BEHCs are high in the sense indicated for several reasons.

(1) Most importantly, as discussed in Vol. 1 Section 3.5, for the same distance and magnitude the Model G16-A3 (G-Expert 5's choice for BE GM model) is higher by a factor of 2 relative to the other BE GM models for rock sites which are lower than G-Expert 5's model for rock. A factor of 2 in PGA results is approximately a factor of 8-10 in probability of exceedance (see also Vol. VI, Section 2.3 for details).

(2) It can be seen from Fig. 3.4 in Vol. I that G-Expert 5's BE PGA (GM model G16-A3) has significantly lower attenuation than the other models particularly at the larger magnitudes. This coupled with the site correction factor for rock increases the contribution from distance zones which have larger earthquakes. For example, a simple calculation would show that for G-Expert 5's model earthquakes of $m_b = 6.0$ have the same PGA at 100 km as $m_b = 5$ earthquakes at 20 km.

(3) G-Expert 5 sets the random uncertainty (standard deviation on the natural log of the PGA) at 0.7 compared to the range of values (0.35 - 0.55) selected by the other G-Experts. Relative to results obtained with a value of 0.55, this larger uncertainty (0.7) leads to an increase in the G-Expert 5's BEHC by about a factor of 2 in probability of exceedance at lower g-values (0.2g) to over a factor of 3 at high g-values (0.9g)

In summary, we typically expect at rock sites that the BEHC for G-Expert 5 for any S-Expert will be about a factor of 10-20 higher in probability of exceedance relative to the other BE GM models (factors (1) and (3) noted above) as illustrated in Fig. 2.1.11 where the BEHCs per G-Expert for S-Expert 1's seismicity input are plotted. In addition, factor (2) is important for all S-Experts because, as noted above, the somewhat distant New Madrid region is important for all S-Experts. Thus the spread between G-Expert 5's BEHC and the other G-Experts BEHCs is somewhat larger than typically observed at rock sites in other volumes of this report.

As a result of the above considerations, the probability distribution of the hazard estimated from the Monte Carlo simulation appears to be slightly skewed towards the higher values of probability of exceedance. Although this phenomenon is not very apparent when all the S-Experts have been combined (i.e., Fig. 2.1.3), it is apparent for some individual S-Experts, such as S-Expert 4, as shown in Fig. 2.1.12. This is the case where the zone that contains the site has a low upper magnitude cutoff and a near-by zone which has a significantly larger upper magnitude cutoff. In this case the low attenuation of model G16-A3 becomes very important and G-Expert 5's BEHC becomes significantly larger (relative to the typical case illustrated in Fig. 2.1.11) than the other BEHCs per G-Expert for a given S-Expert's input. It can be seen from Table 2.1.1 and the map for S-Expert 4 in Appendix B, that, zone 4 which contribute most to the hazard is some distance from the site as shown in Fig. 2.1.13. The upper magnitude cutoff in the CZ which contains the site is only 5.5 whereas it is 7.5 for zone 4.

Figure 2.1.6 shows the 1000 year return period best estimate uniform hazard response spectra for 5% damping for all the S-Experts. These 11 curves show a rather even spread with some departure from the overall trend at 1 sec period for Expert 3, Expert 11 (symbol "B") and Expert 13 (symbol "D"). For these S-Experts, the contribution comes from earthquakes in the low to medium magnitude range (i.e. 5 to 6.5) as opposed to high (i.e. above 6.5). Thus observing the behavior of the GM spectra models in Figs. 3.7 and 3.8 of Volume I we see that the BEUHS for S-Expert 11 will be lower at 1 sec. than at .4 sec. This set of circumstances does not appear for the other S-Experts at this site.

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TABLE 2.1.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR ARKANSAS

SITE SOIL CATEGORY ROCK

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 5	ZONE ID:	ZONE 5	ZONE 9	ZONE 10	ZONE 11	ZONE 9	ZONE 5	ZONE 10	ZONE 13
		% CONT.:	39.	36.	19.	2.	55.	35.	10.	0.
2	COMP. ZO	ZONE ID:	ZONE 18	COMP. ZON	ZONE 19	ZONE 20	ZONE 18	COMP. ZON	ZONE 4	ZONE 19
		% CONT.:	91.	4.	2.	2.	98.	1.	0.	0.
3	ZONE 14	ZONE ID:	ZONE 14	ZONE 13	ZONE 12	ZONE 16	ZONE 14	ZONE 13	ZONE 12	ZONE 16
		% CONT.:	56.	26.	16.	1.	79.	16.	5.	0.
4	COMP. ZO	ZONE ID:	ZONE 4	ZONE 3	ZONE 2	ZONE 5	ZONE 4	ZONE 3	ZONE 2	ZONE 13
		% CONT.:	91.	6.	1.	1.	99.	1.	0.	0.
5	COMP. ZO	ZONE ID:	ZONE 15	ZONE 17	ZONE 14	COMP. ZON	ZONE 15	COMP. ZON	ZONE 14	ZONE 17
		% CONT.:	88.	7.	5.	1.	100.	0.	0.	0.
6	ZONE 19	ZONE ID:	ZONE 17	ZONE 25	ZONE 19	ZONE 18	ZONE 19	ZONE 25	ZONE 17	ZONE 18
		% CONT.:	37.	25.	23.	14.	35.	23.	22.	20.
7	ZONE 30	ZONE ID:	ZONE 6	ZONE 30	ZONE 5	ZONE 2 =	ZONE 6	ZONE 30	ZONE 5	ZONE 2 =
		% CONT.:	76.	14.	10.	0.	85.	13.	2.	0.
10	ZONE 19	ZONE ID:	ZONE 29	ZONE 12A	ZONE 19 =	ZONE 13	ZONE 29	ZONE 19 =	ZONE 12A	ZONE 13
		% CONT.:	41.	36.	18.	5.	68.	16.	16.	0.
11	ZONE 15	ZONE ID:	ZONE 15	ZONE 11	ZONE 10	CZ = ZONE	ZONE 15	ZONE 11	ZONE 10	CZ = ZONE
		% CONT.:	77.	14.	7.	1.	92.	7.	1.	0.
12	ZONE 4 =	ZONE ID:	ZONE 15	ZONE 13	ZONE 14	ZONE 3	ZONE 15	ZONE 14	ZONE 3	ZONE 13
		% CONT.:	30.	29.	24.	8.	70.	13.	8.	7.
13	ZONE 1	ZONE ID:	ZONE 5	ZONE 1	CZ 15	ZONE 4	ZONE 1	ZONE 5	CZ 15	ZONE 4
		% CONT.:	45.	42.	6.	3.	59.	37.	4.	0.

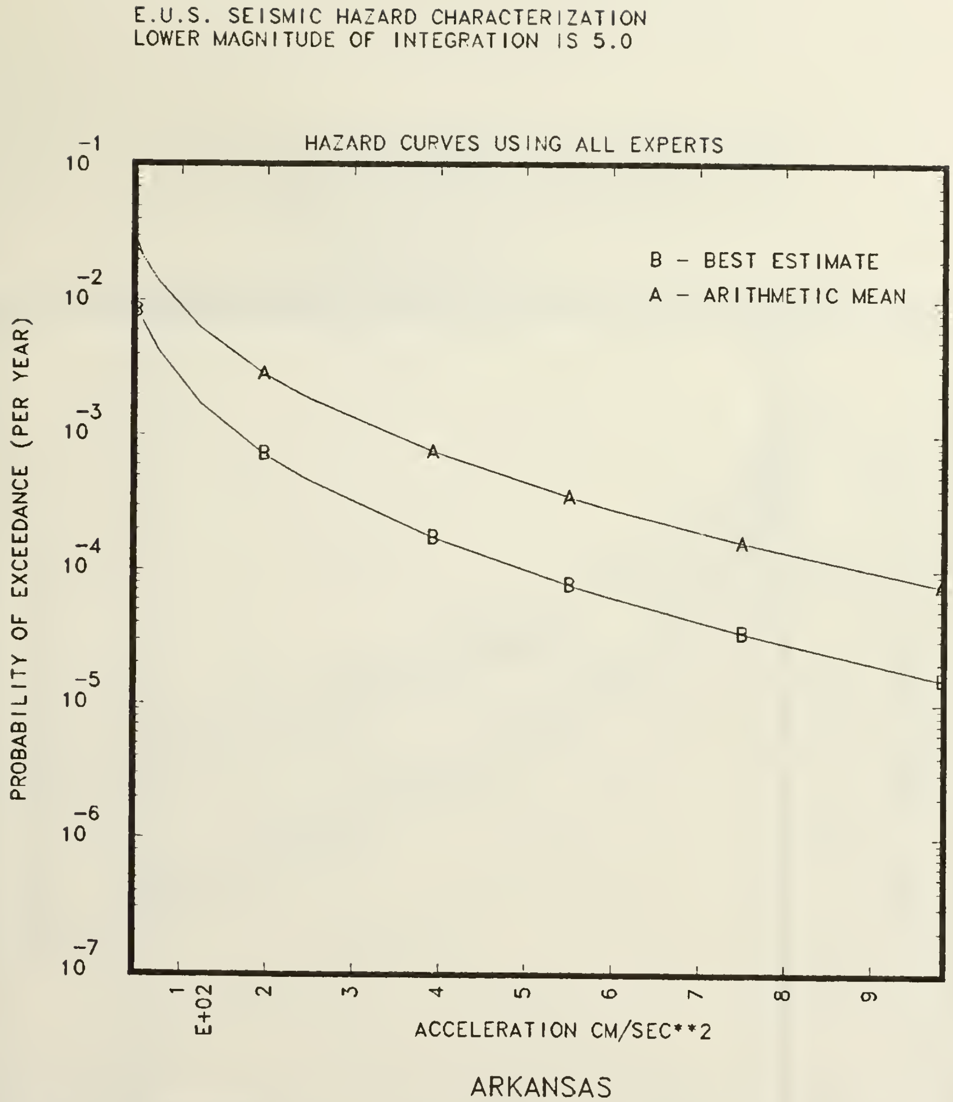

Figure 2.1.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Arkansas site.

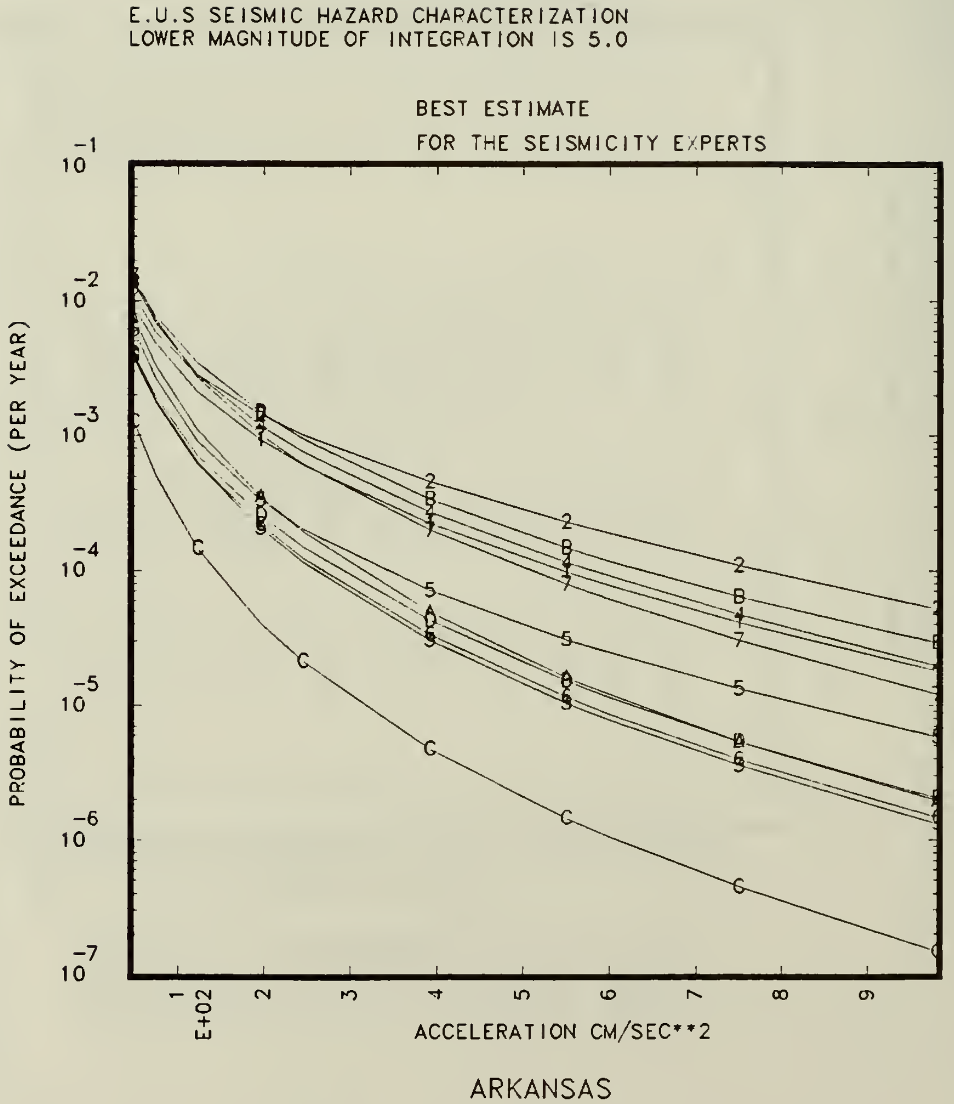

Figure 2.1.2 BEHCs per S-Expert combined over all G-Experts for the Arkansas site. Plot symbols given in Table 2.0.

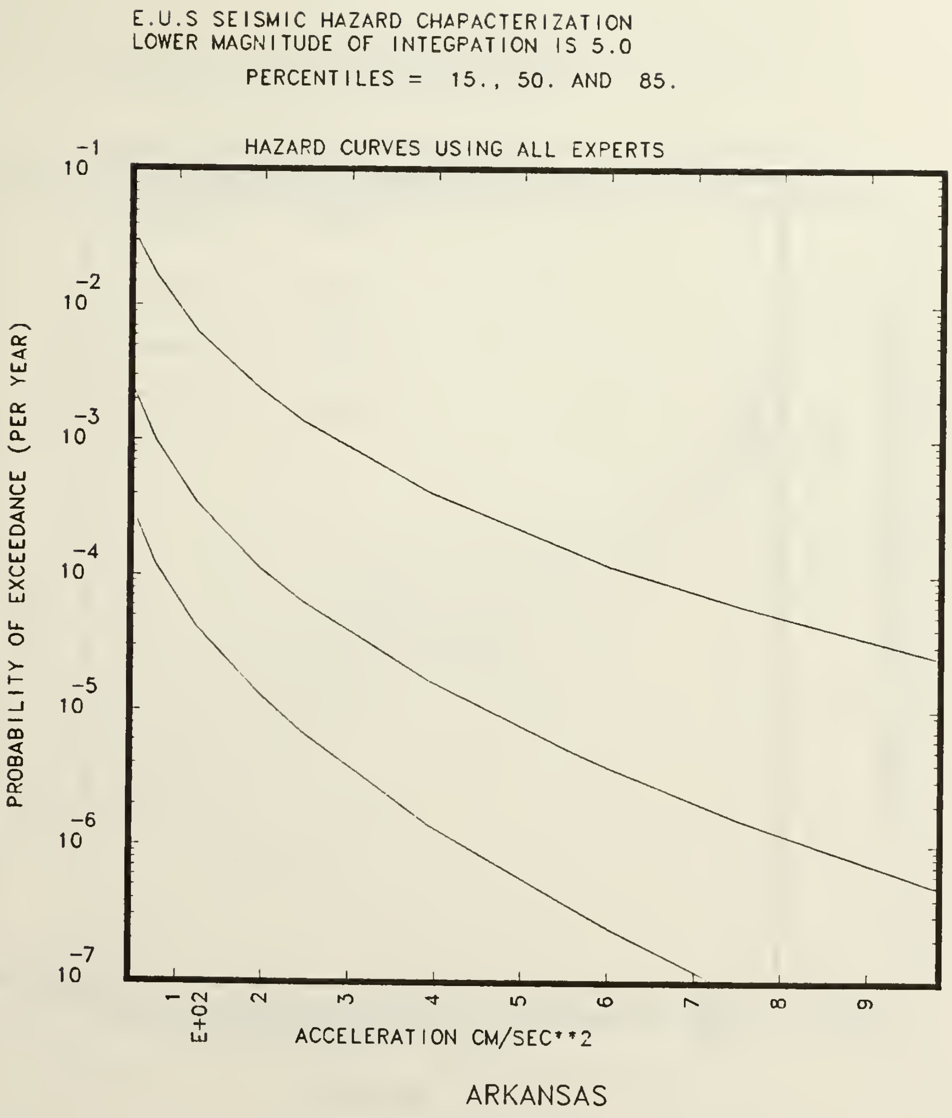

Figure 2.1.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Arkansas site.

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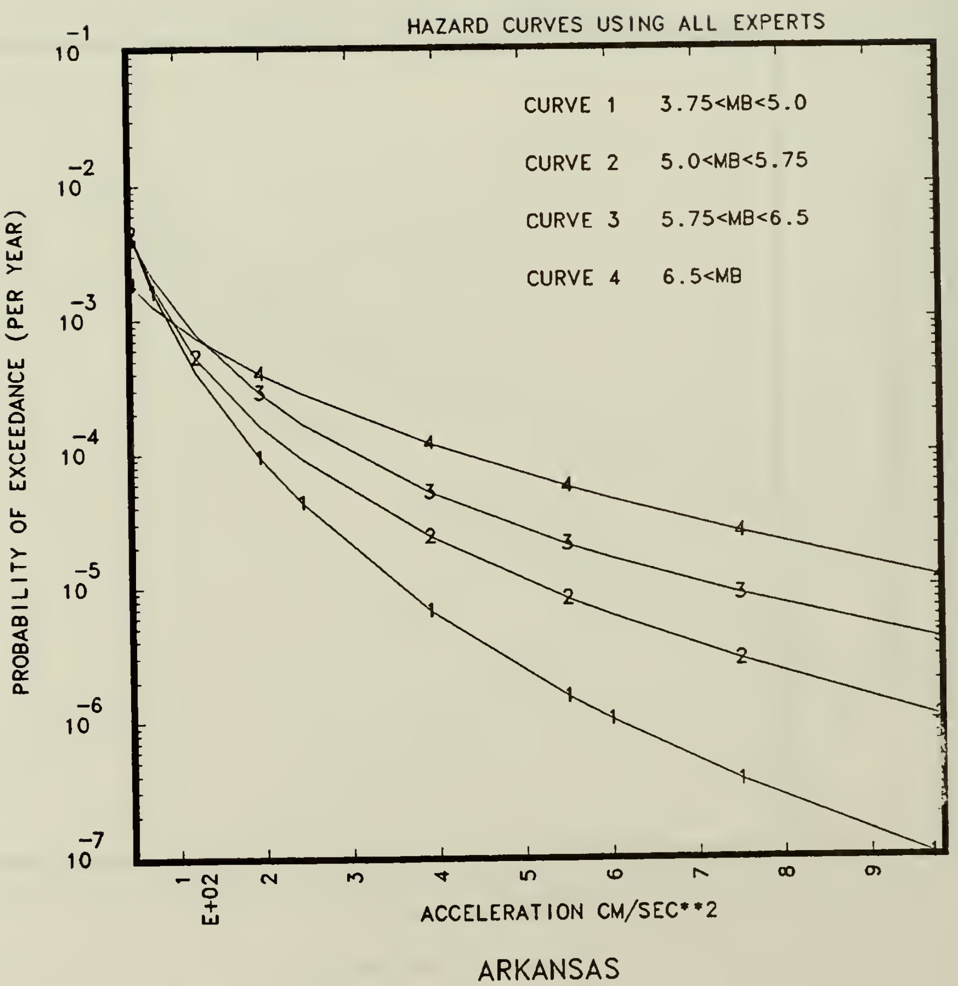

Figure 2.1.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Arkansas site.

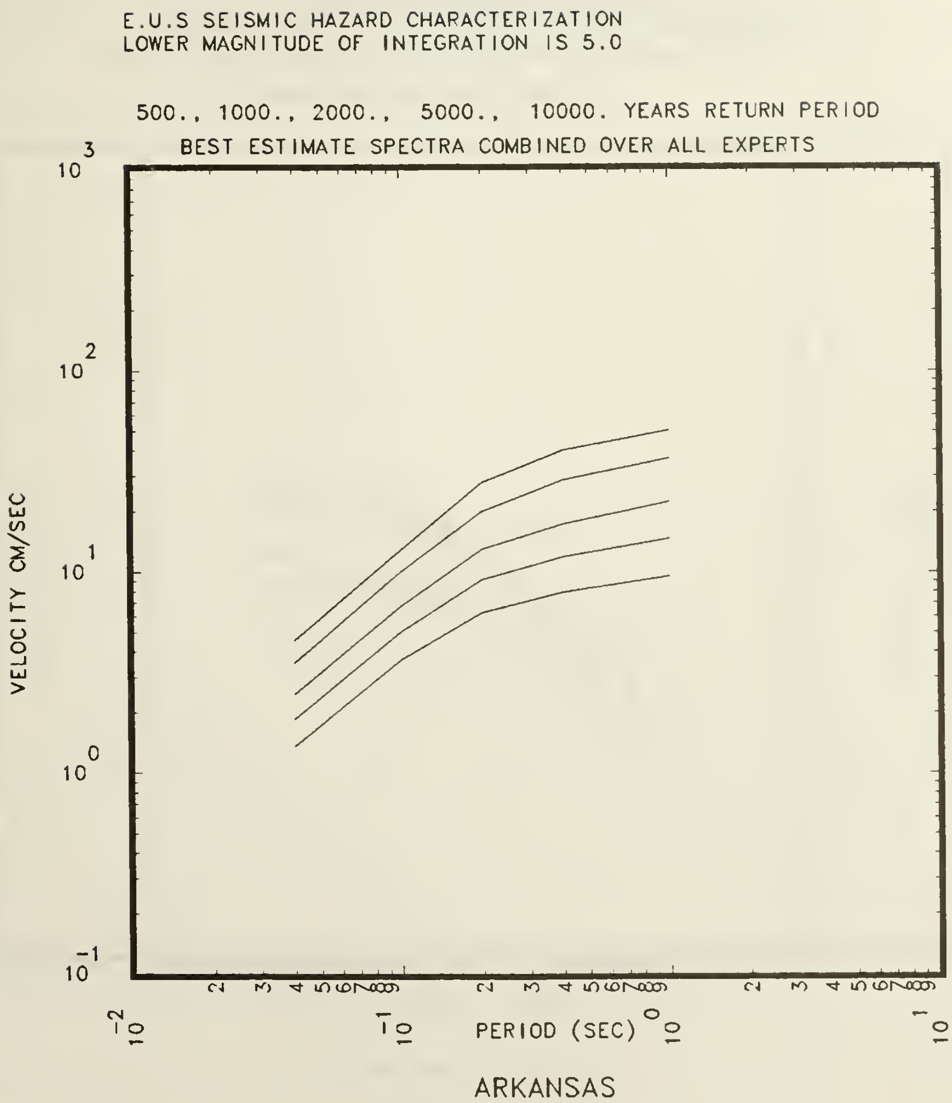

Figure 2.1.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Arkansas site.

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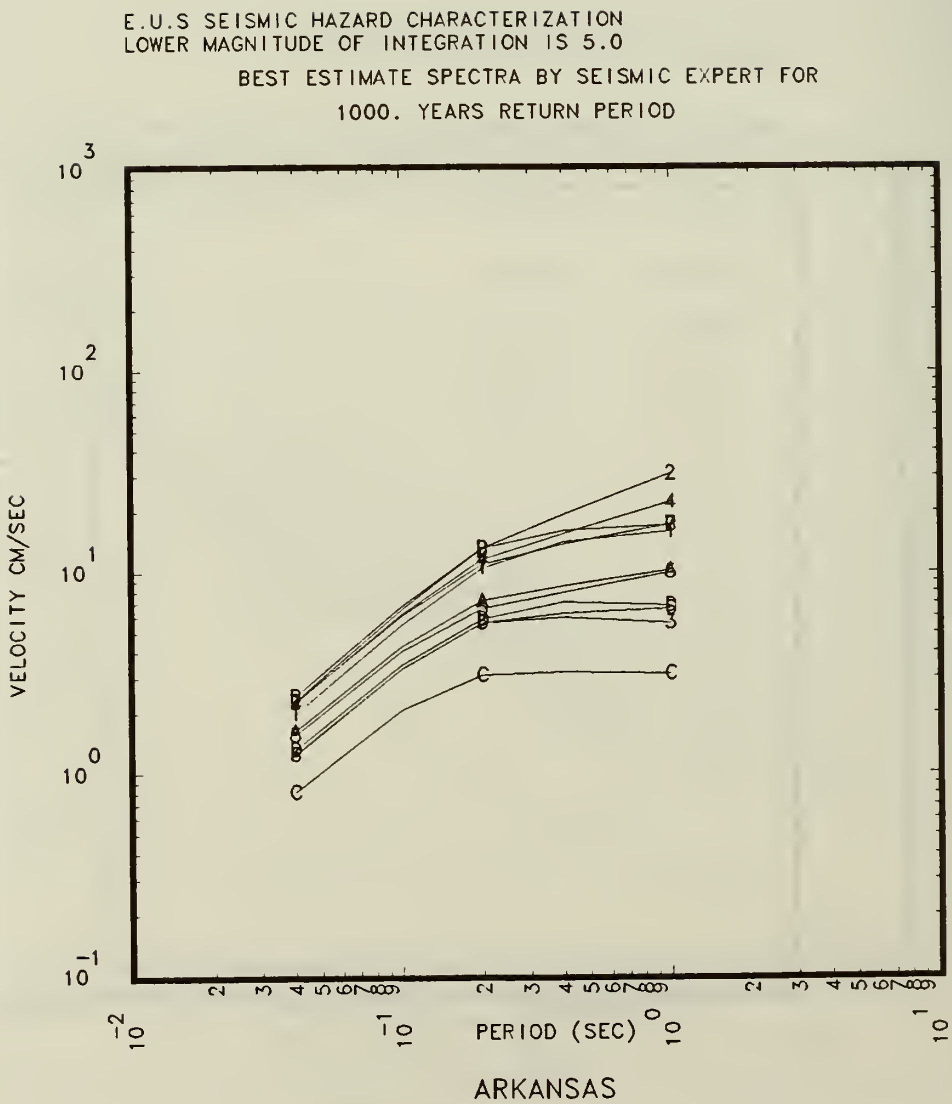

Figure 2.1.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Arkansas site. Plot symbols are given in Table 2.0.

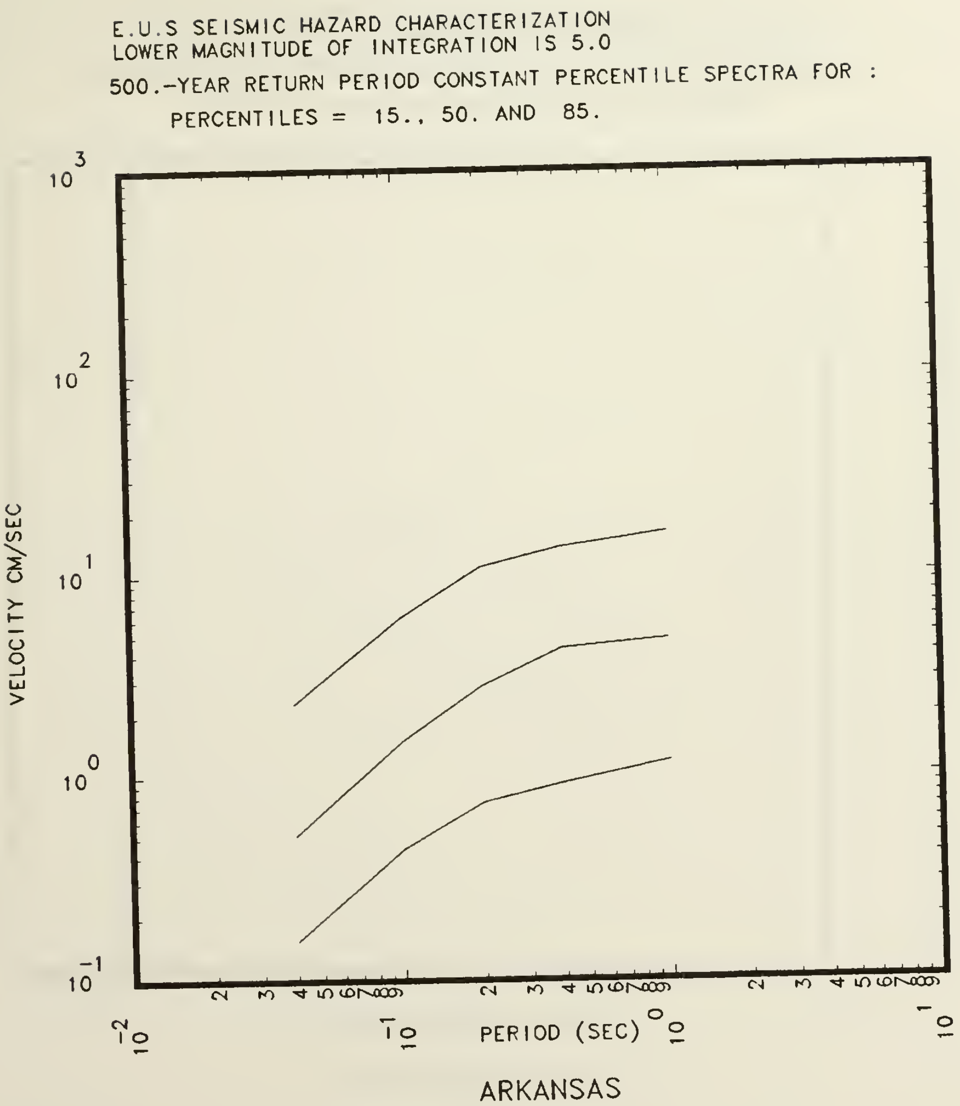

Figure 2.1.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Arkansas site.

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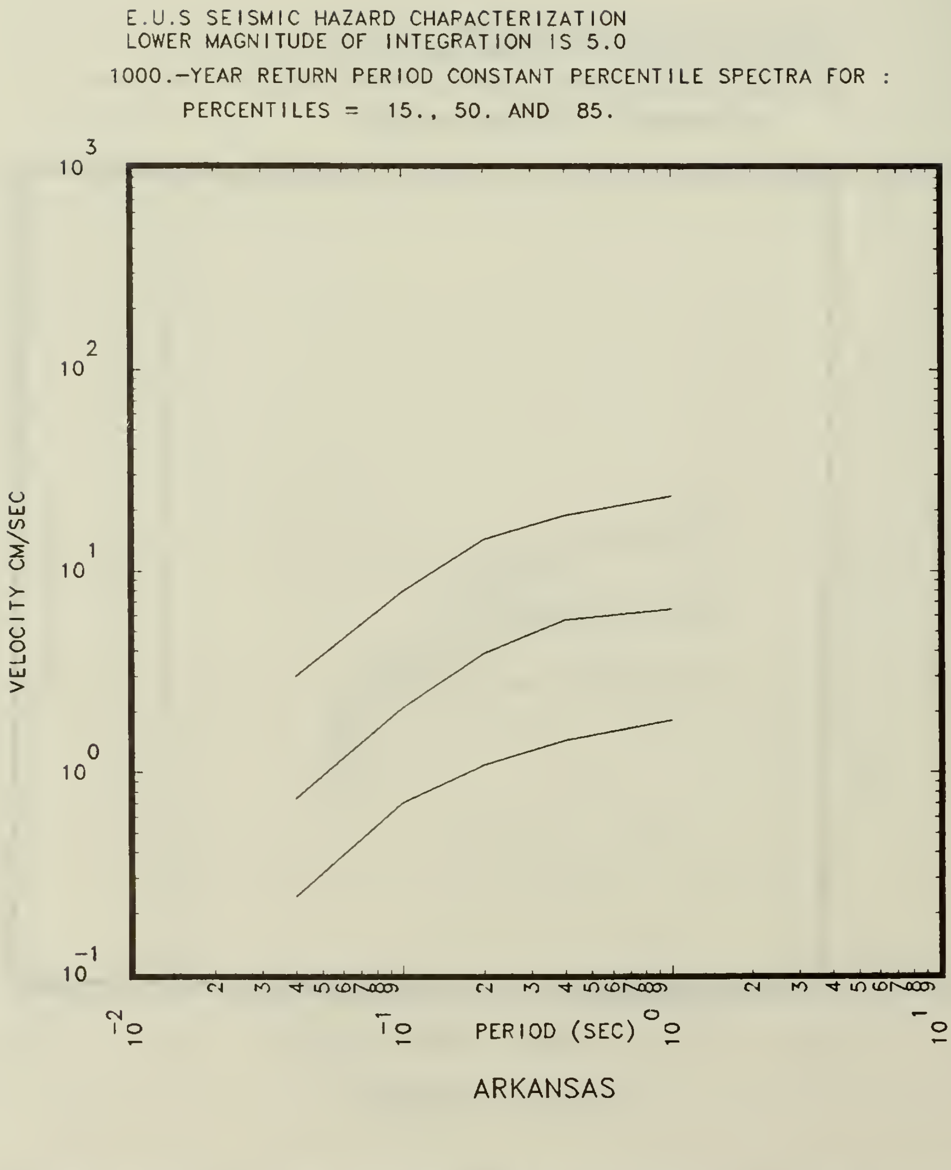

Figure 2.1.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Arkansas site.

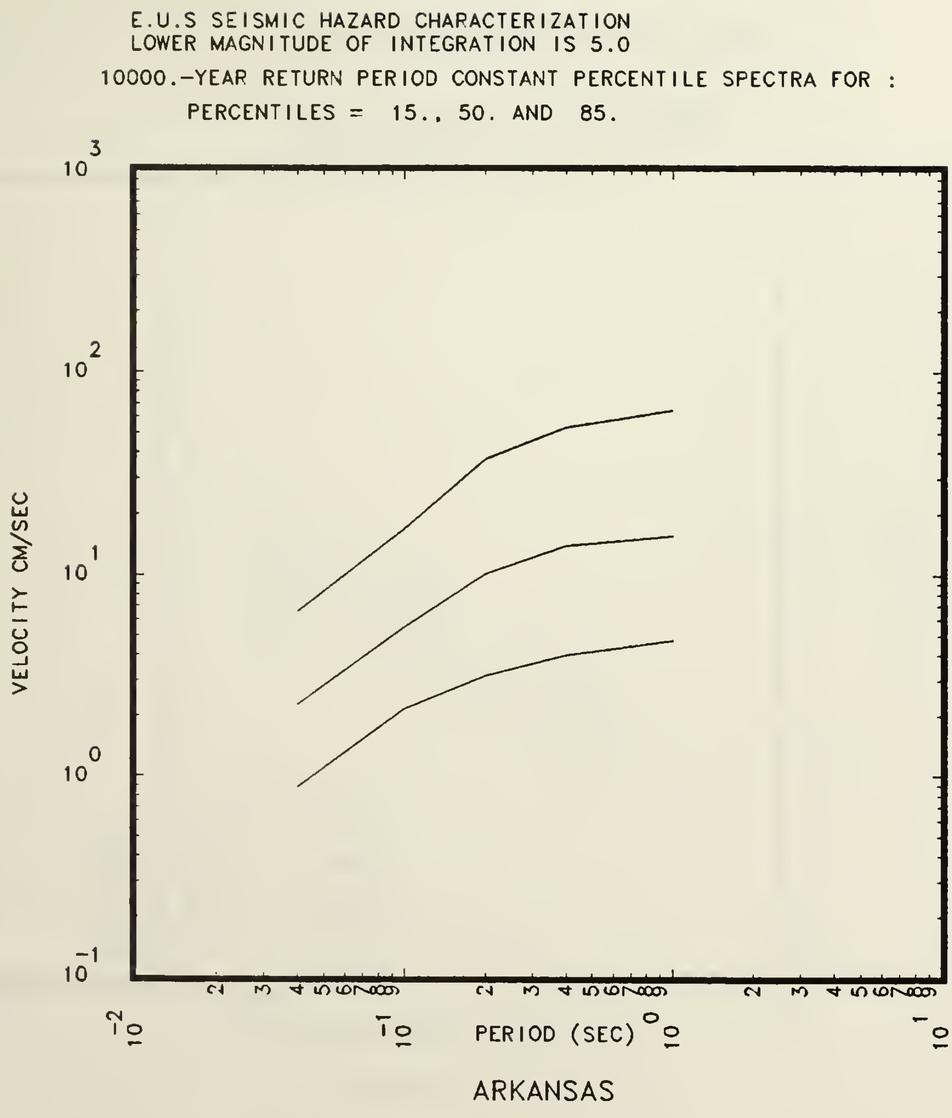

Figure 2.1.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Arkansas site.

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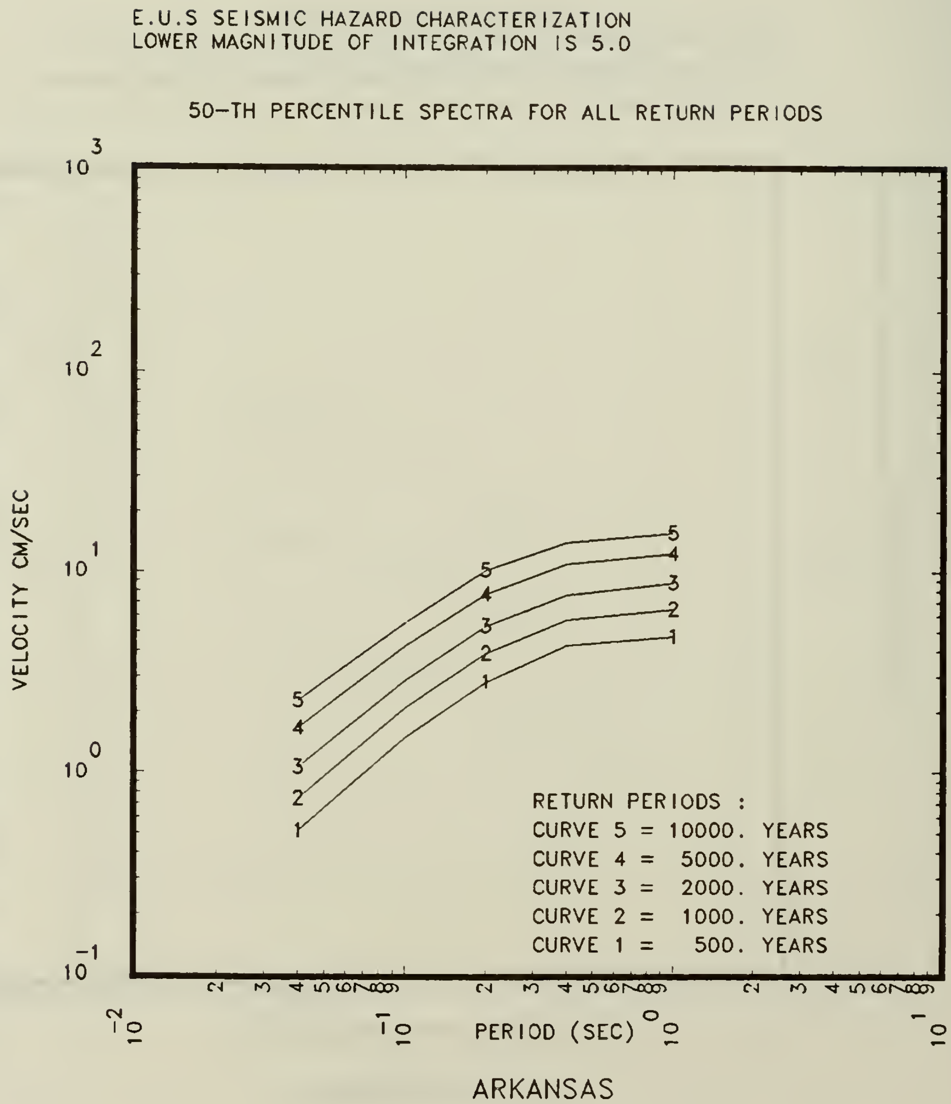

Figure 2.1.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Arkansas site.

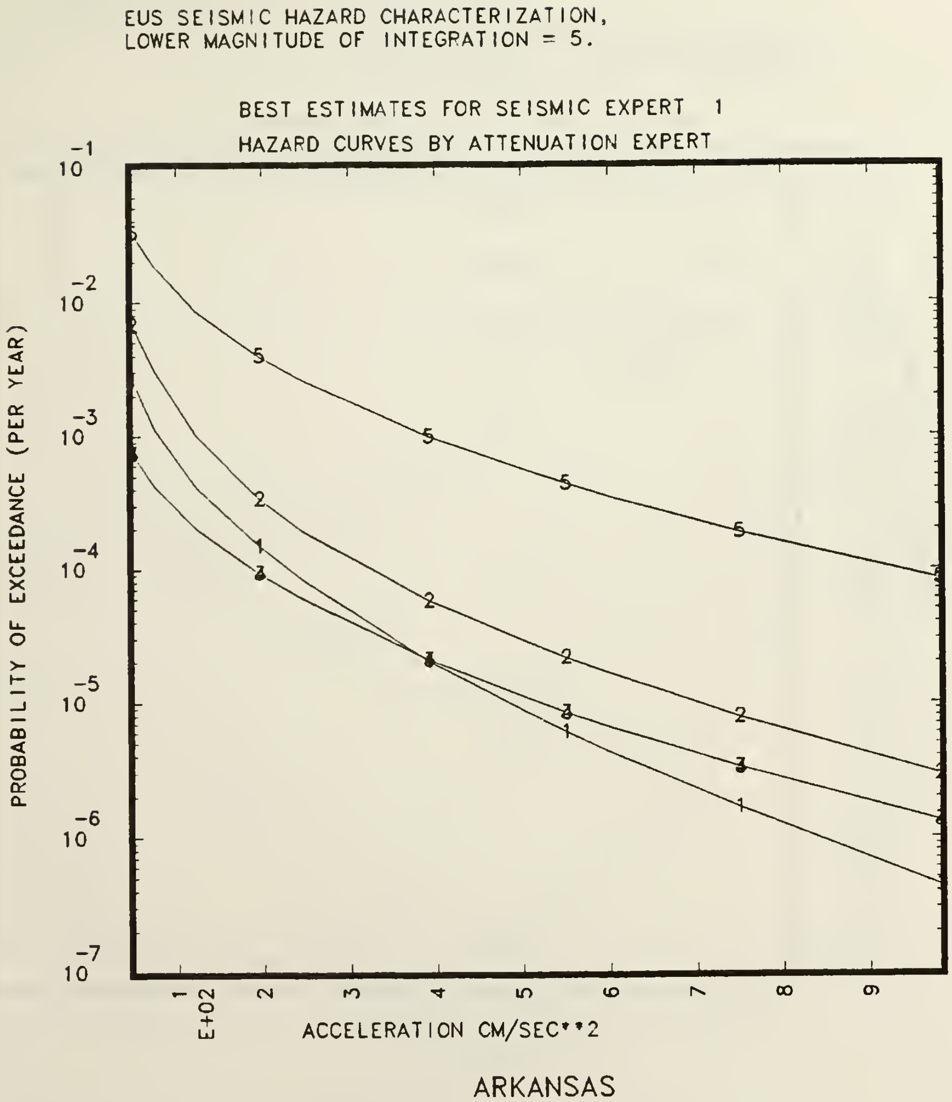

Figure 2.1.11 Comparison of the BEHCs per G-Expert for S-Expert 1's input for the Arkansas site.

EUS SEISMIC HAZARD CHARACTERIZATION,
LOWER MAGNITUDE OF INTEGRATION = 5.

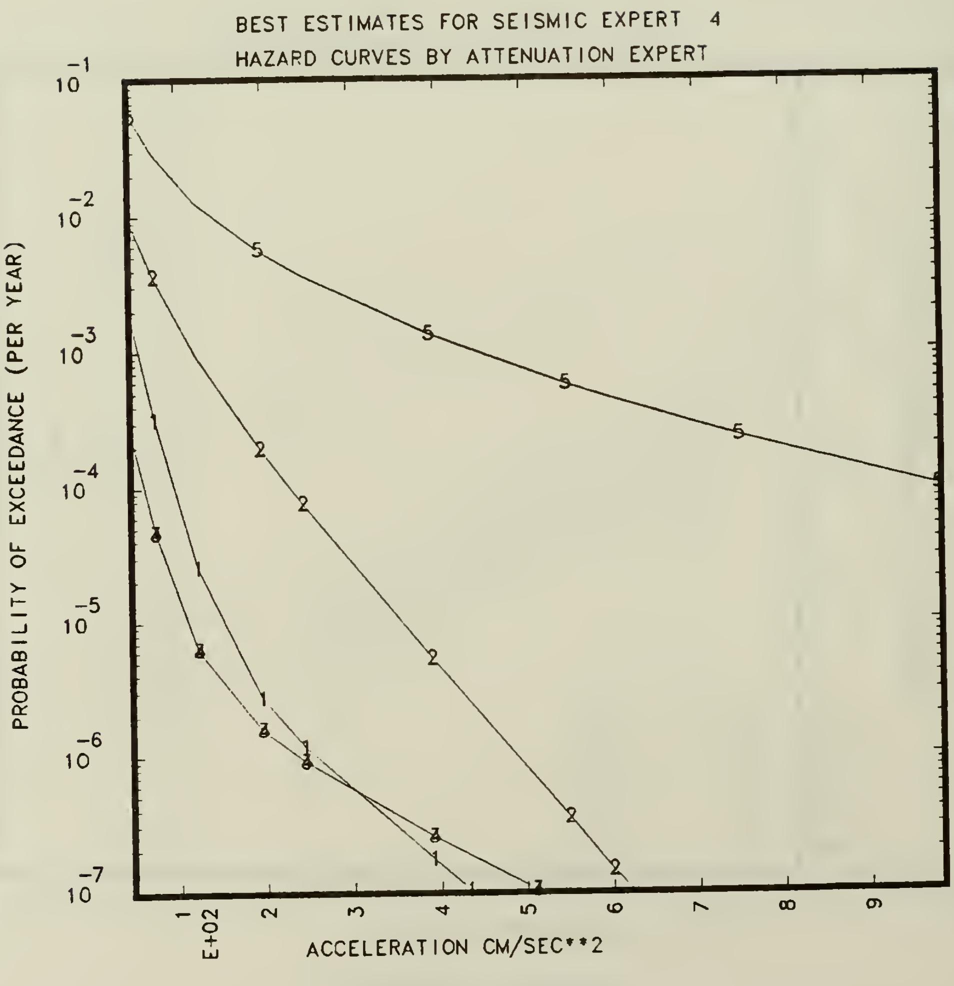

Figure 2.1.12 Comparison of the BEHCs per G-Expert for S-Expert 4's input for the Arkansas site.

CONTRIBUTION TO THE HAZARD FOR PGA
FROM THE EARTHQUAKES IN 4 DISTANCE RANGES

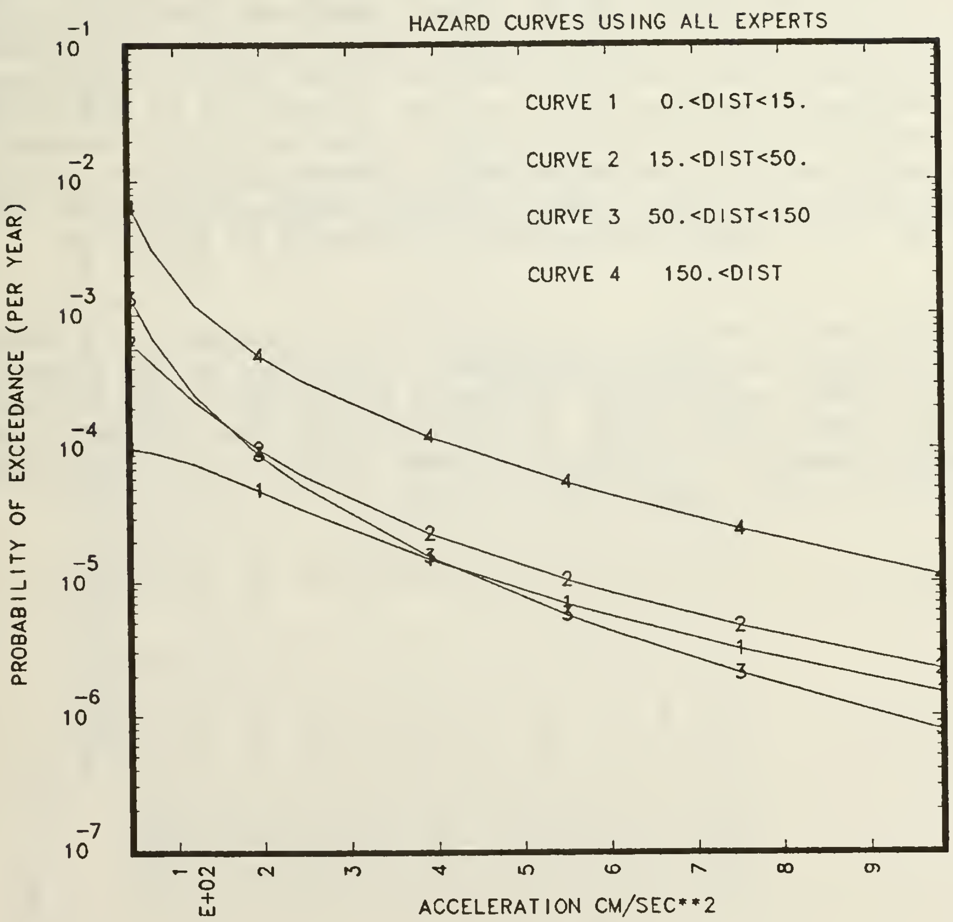

Figure 2.1.13 BEHCs which include only the contribution to the PGA hazard for earthquakes within the indicated distance ranges for the Arkansas site.

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2.2 CALLAWAY

Callaway is a rock site and is represented by the symbol "2" in Fig. 1.1. Table 2.2.1 and Figs. 2.2.1 to 2.2.10 give the results of the analysis for this site. The AMHC is higher than the 85th percentile and the BEHC is between the 50th and the 85th percentile. This indicates the presence of some outlier curves in the simulation. Table 2.2.1 shows that for 9 of the 11 S-Experts, the Callaway site is located inside a complementary zone, with a relatively low upper magnitude cutoff and low occurrence rates. Thus the dominant zones are distant zones which have high rates of occurrence and higher upper magnitude cutoffs such as the New Madrid zone. Indeed, areas located 150 km or more from the site contribute most to the BEHC for PGA.

S-Expert 12 (symbol "C") appears to be an outlier in Fig. 2.2.2. This is because for this expert, the Callaway site is located in the complementary zone (zone 4) which has a best estimate upper magnitude cutoff of 5.0 (see Table B12.1 in Vol. I), thus the first zones which contribute anything are already distant enough that the ground motion at the site be significantly attenuated, because the analysis only includes earthquakes of magnitude 5.0 and above. Fig. 2.2.4 shows that the biggest contribution is from earthquakes greater than magnitude 6.5, and earthquakes of magnitude between 3.75 and 5.0 contributing only very little. Hence including earthquakes in that latter range would not have changed the hazard significantly at this site.

The discussion given in Section 2.1 relative to the dominance of G-Expert 5's GM model for the BEHC and AMHC also applies. In particular the spread between the G-Expert 5's BEHC and the other G-Experts per S-Experts 3,5,6,11 and 13 is similar to the spread shown in Fig. 2.1.11. For the other S-Experts, the spread between G-Expert 5's BEHC and the other G-Experts BEHC per S-Expert is large and similar to that shown in Fig. 2.1.12.

TABLE 2.2.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR CALLAWAY

SITE SOIL CATEGORY ROCK

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 15	ZONE ID:	ZONE 10	ZONE 9	ZONE 11	ZONE 15	ZONE 9	ZONE 10	ZONE 11	ZONE 15
		% CONT.:	45.	34.	18.	1.	48.	44.	8.	0.
2	COMP. ZO	ZONE ID:	ZONE 18	ZONE 19	ZONE 20	COMP. ZON	ZONE 18	ZONE 19	COMP. ZON	ZONE 20
		% CONT.:	75.	12.	10.	3.	95.	3.	1.	1.
3	ZONE 16	ZONE ID:	ZONE 12	ZONE 13	ZONE 16	ZONE 14	ZONE 12	ZONE 13	ZONE 16	COMP. ZON
		% CONT.:	58.	26.	15.	0.	64.	18.	18.	0.
4	ZONE 13	ZONE ID:	ZONE 4	ZONE 3	ZONE 5	ZONE 13	ZONE 4	ZONE 3	ZONE 5	ZONE 13
		% CONT.:	73.	15.	11.	0.	90.	7.	3.	0.
5	ZONE 14	ZONE ID:	ZONE 15	ZONE 14	ZONE 17	COMP. ZON	ZONE 15	ZONE 14	COMP. ZON	ZONE 10
		% CONT.:	50.	49.	1.	0.	56.	44.	0.	0.
6	COMP. ZO	ZONE ID:	ZONE 17	ZONE 18	COMP. ZON	ZONE 27	ZONE 17	ZONE 18	COMP. ZON	ZONE 27
		% CONT.:	85.	10.	2.	1.	85.	12.	3.	0.
7	ZONE 2 =	ZONE ID:	ZONE 6	ZONE 5	ZONE 2 =	ZONE 30	ZONE 6	ZONE 5	ZONE 2 =	ZONE 1
		% CONT.:	88.	11.	1.	0.	97.	2.	1.	0.
10	ZONE 19	ZONE ID:	ZONE 12A	ZONE 13	ZONE 19 =	ZONE 32	ZONE 19 =	ZONE 12A	ZONE 13	ZONE 4B
		% CONT.:	36.	34.	29.	1.	53.	31.	16.	0.
11	CZ = ZON	ZONE ID:	ZONE 10	CZ = ZONE	ZONE 11	ZONE 15	ZONE 10	CZ = ZONE	ZONE 11	ZONE 15
		% CONT.:	63.	17.	16.	4.	63.	22.	14.	0.
12	ZONE 4 =	ZONE ID:	ZONE 13	ZONE 15	ZONE 14	ZONE 3	ZONE 15	ZONE 13	ZONE 14	ZONE 3
		% CONT.:	63.	20.	15.	1.	50.	43.	7.	0.
13	CZ 15	ZONE ID:	ZONE 5	CZ 15	ZONE 6	ZONE 3	ZONE 5	CZ 15	ZONE 6	ZONE 3
		% CONT.:	54.	18.	17.	6.	67.	28.	4.	1.

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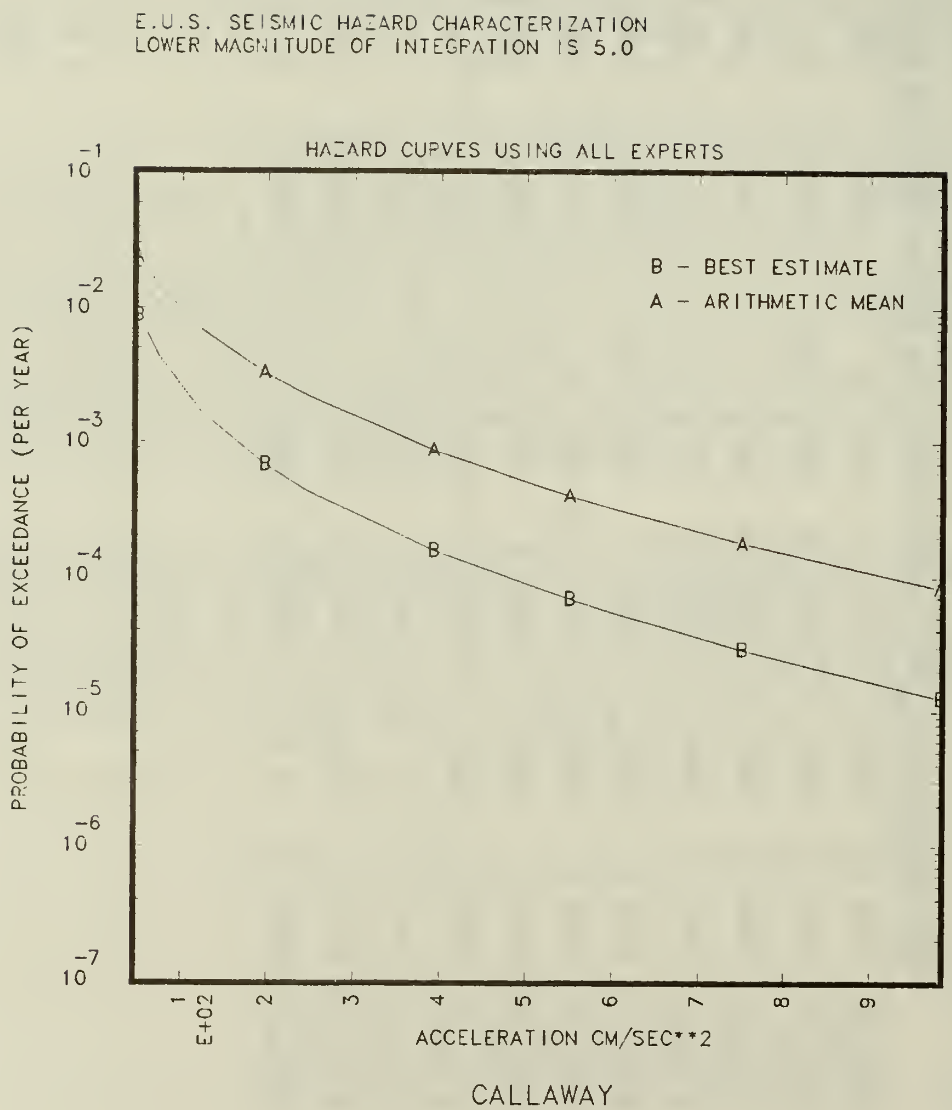

Figure 2.2.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Callaway site.

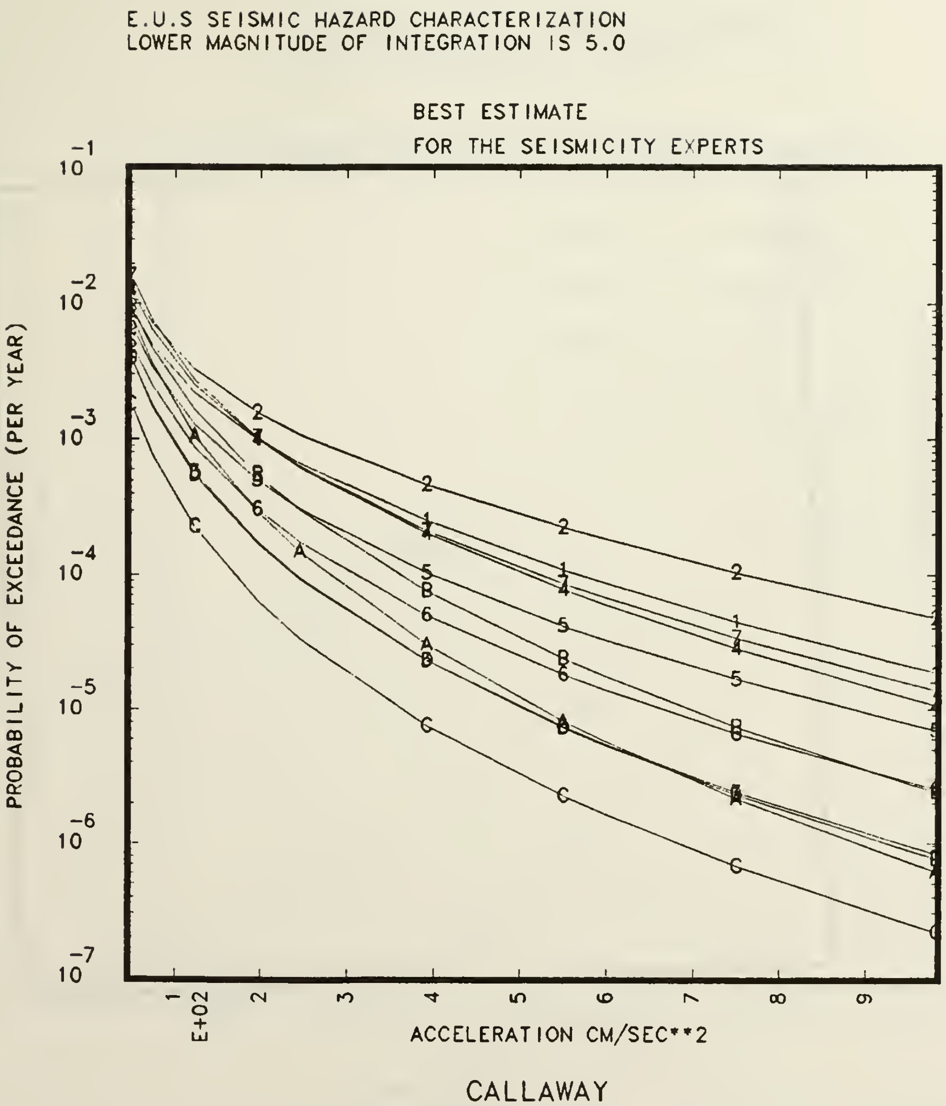

Figure 2.2.2 BEHCs per S-Expert combined over all G-Experts for the Callaway site. Plot symbols given in Table 2.0.

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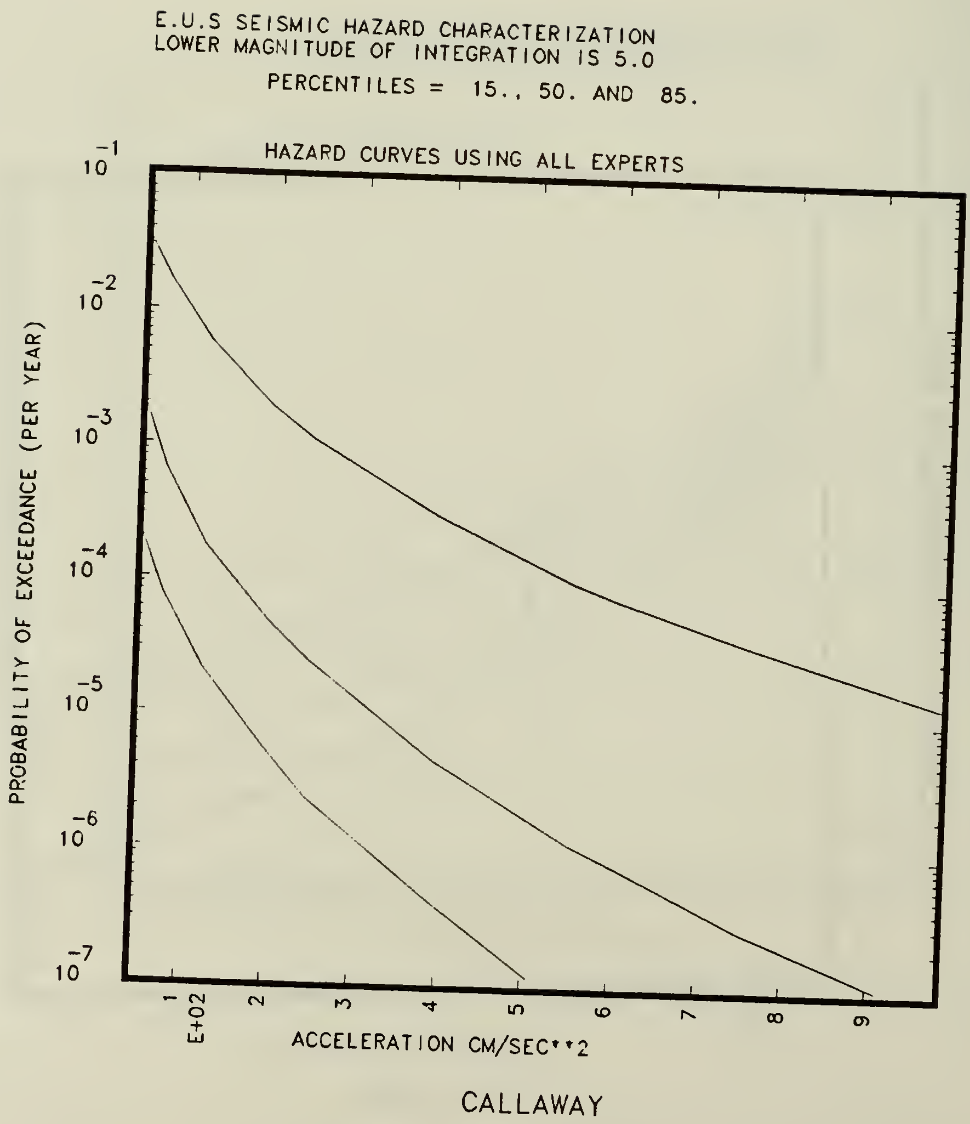

Figure 2.2.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Callaway site.

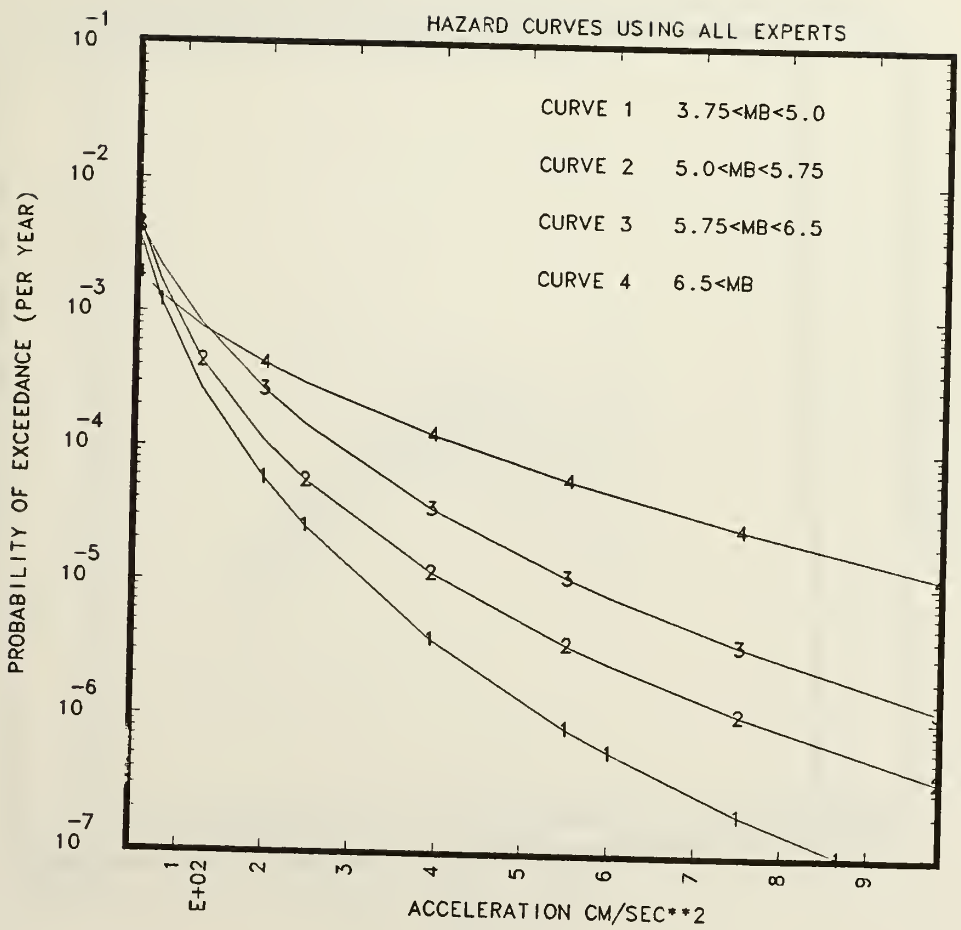

Figure 2.2.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Callaway site.

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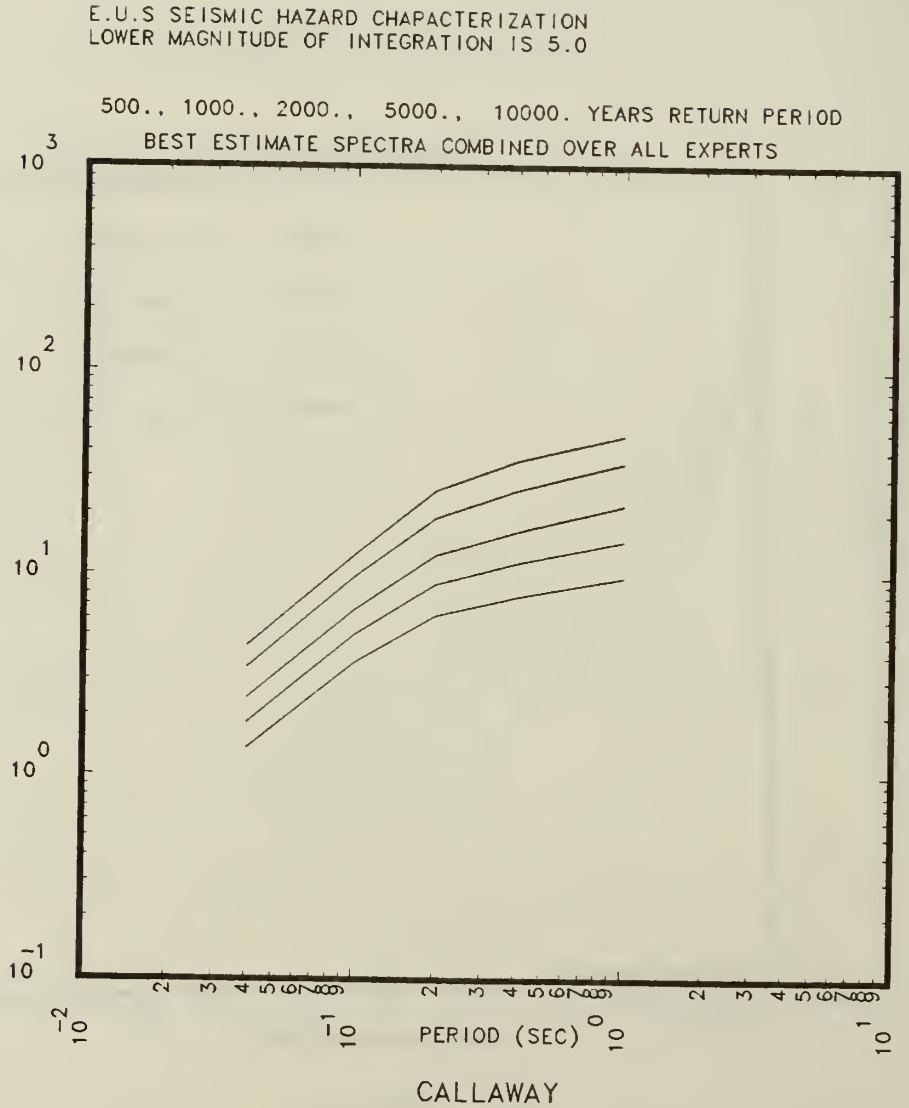

Figure 2.2.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Callaway site.

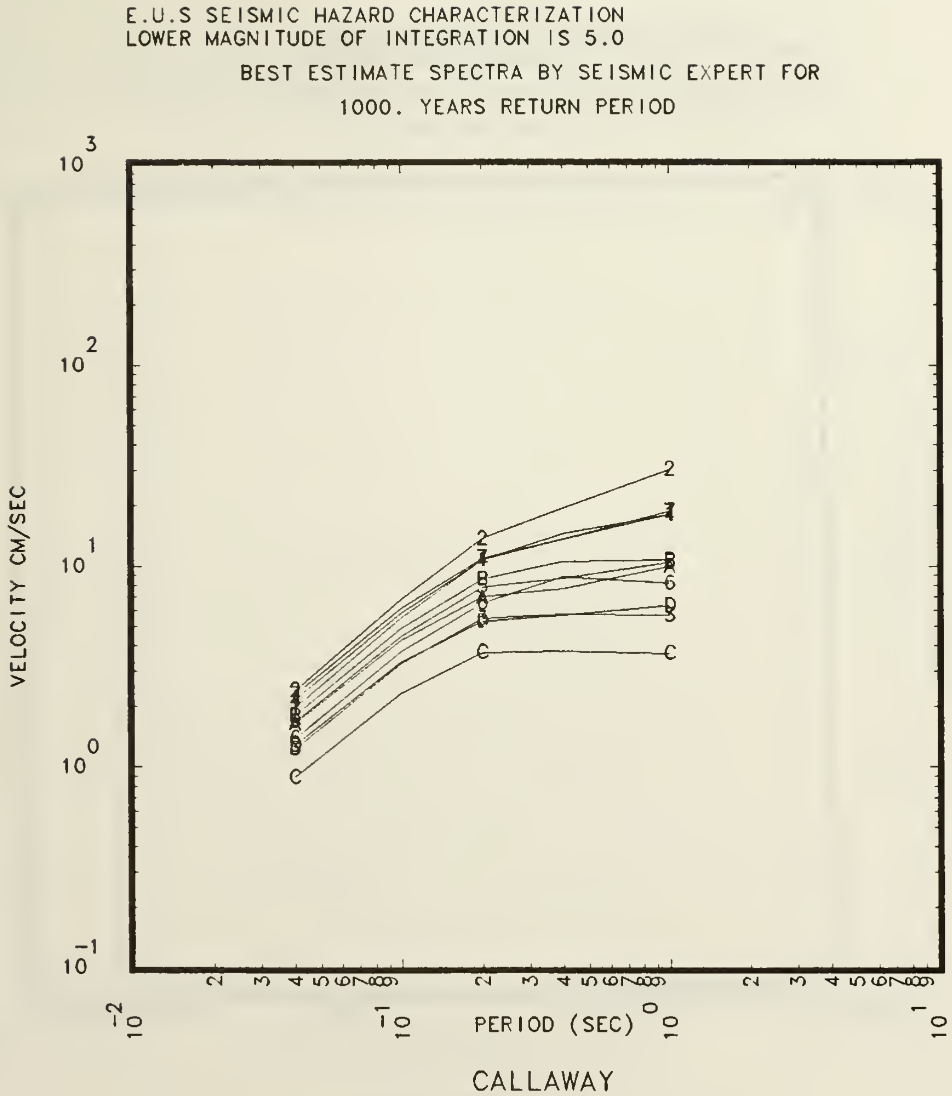

Figure 2.2.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Callaway site. Plot symbols are given in Table 2.0.

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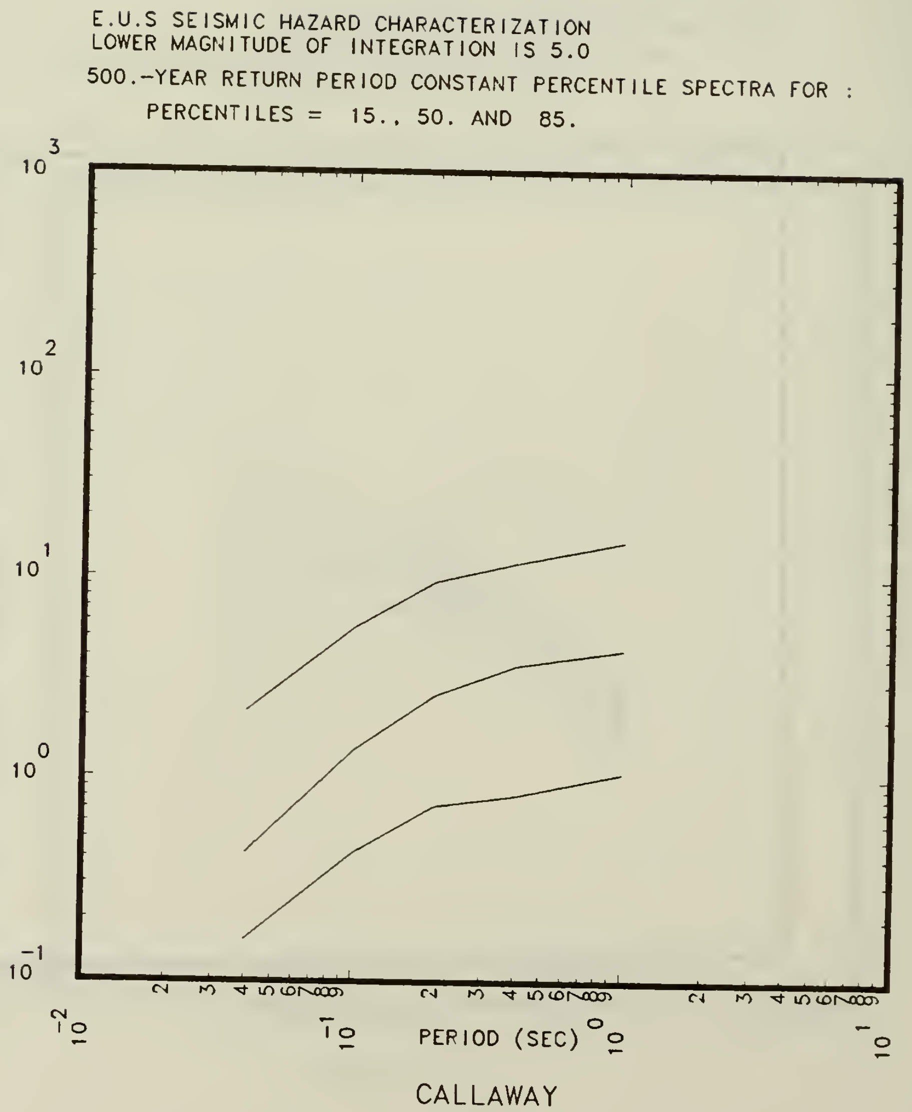

Figure 2.2.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Callaway site.

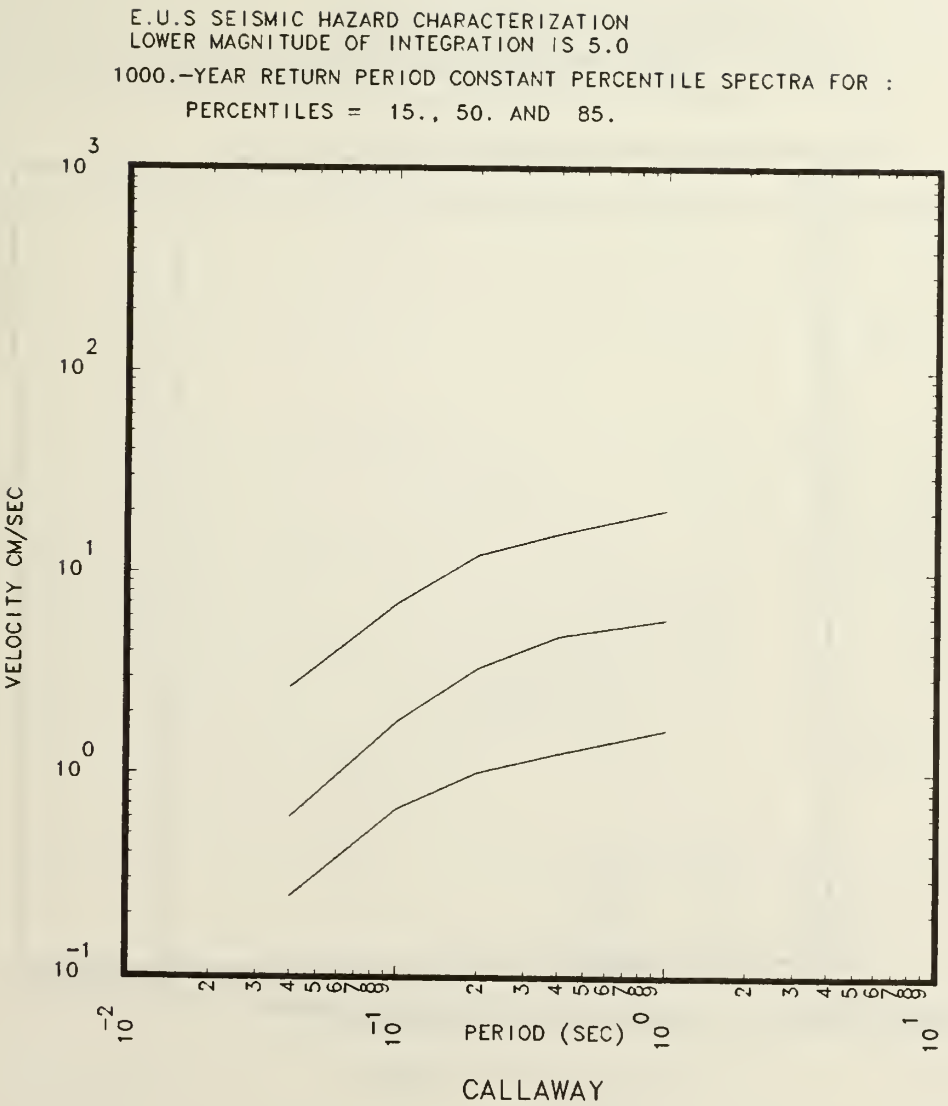

Figure 2.2.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Callaway site.

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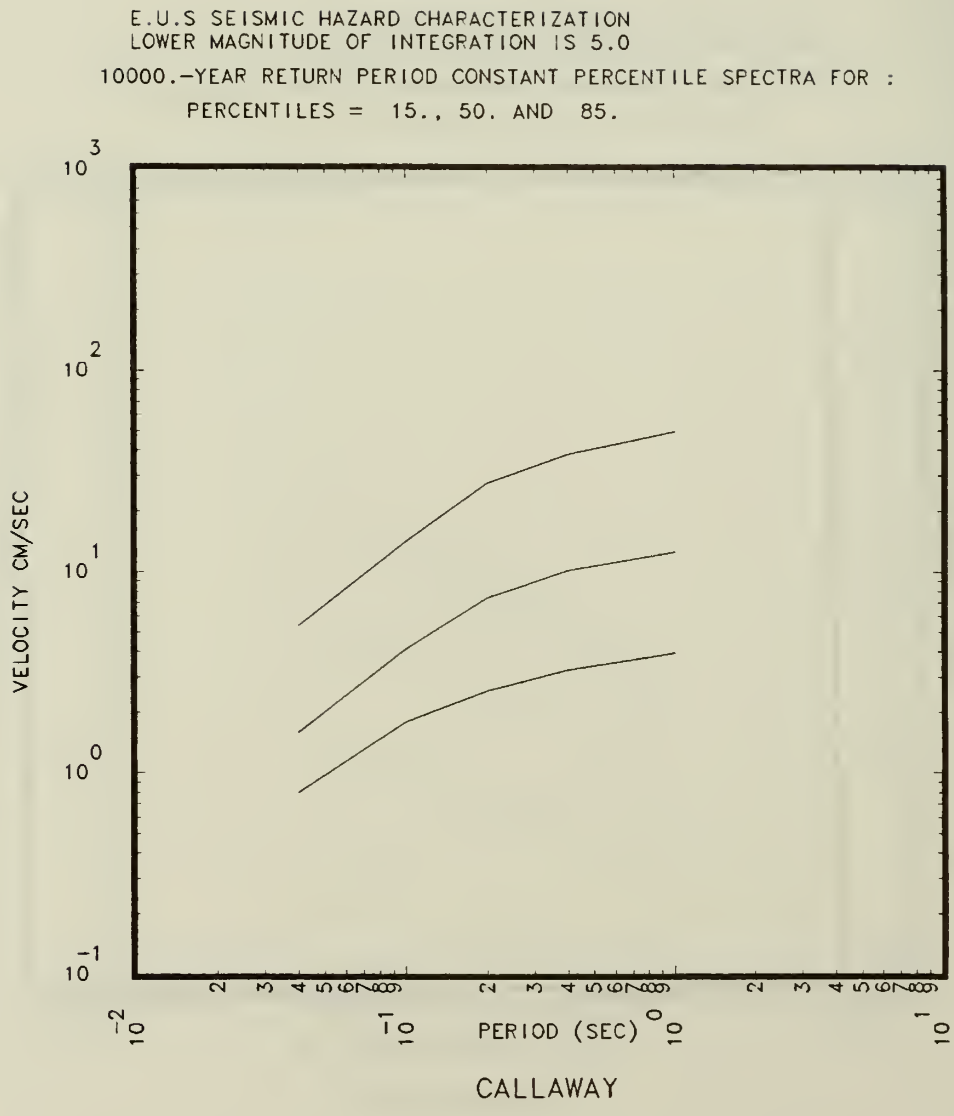

Figure 2.2.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Callaway site.

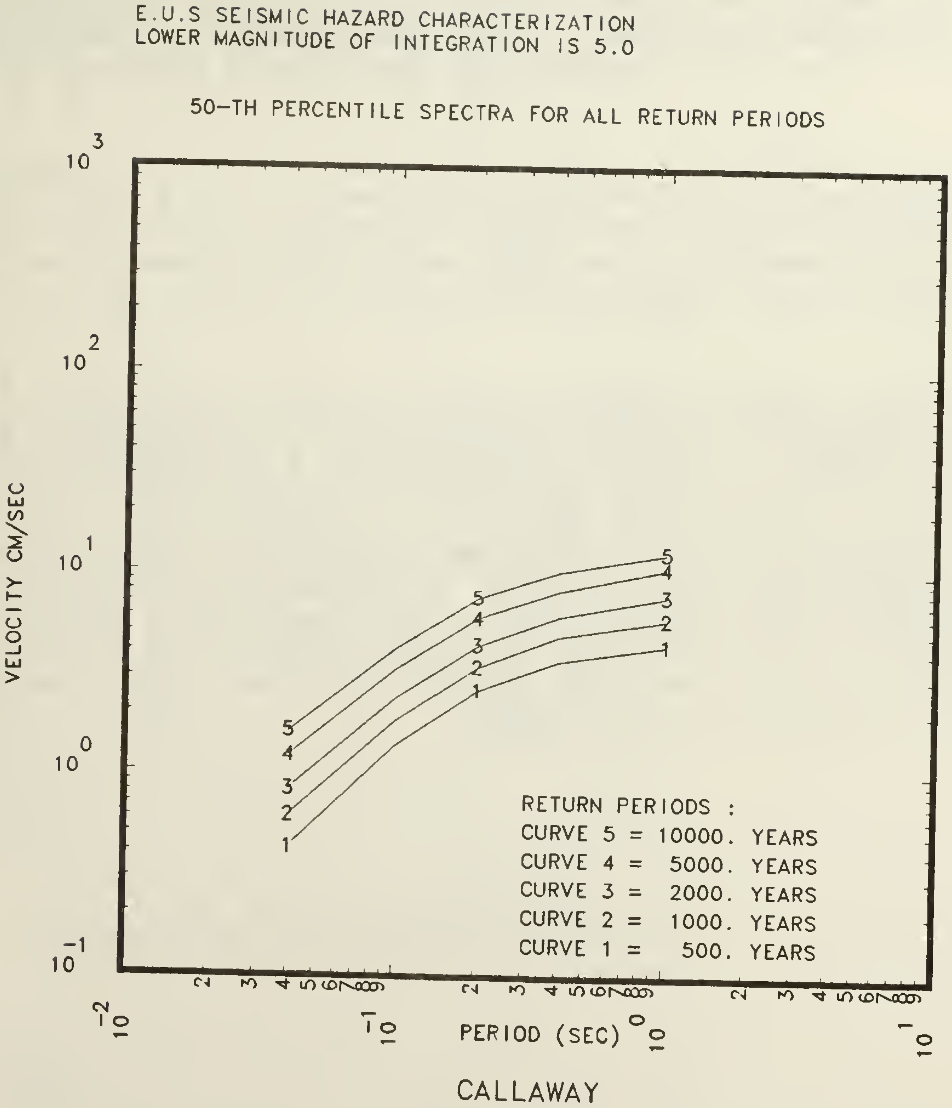

Figure 2.2.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Callaway site.

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2.3 COMANCHE PEAK

Comanche Peak is a rock site and is represented by the symbol "3" in Fig. 1.1. Table 2.2.1 and Figs. 2.2.1 to 2.2.10 give the results of the analysis for this site. The AMHC is higher than the 85th percentile and the BEHC is between the 50th and the 85th percentile. This indicates the presence of some outlier curves in the simulation. Table 2.2.1 shows that for most S-Experts, the Comanche Peak site is located inside a complementary zone. Typically, the various C.Z. have a relatively low upper magnitude cutoffs and low occurrence rates. Thus for a number of S-Experts the dominant zones are distant zones which have high rates of occurrence and higher upper magnitude cutoffs such as the New Madrid zone. However, the site is far enough away from the New Madrid region so that for other S-Experts either the host zone or some other nearby zone is more significant than the New Madrid zone. Figure 2.3.11 indicates that at least for the combined BEHC for PGA that the hazard comes for its most part from areas located 150 km or more from the site.

Fig. 2.2.4 shows that the biggest contribution is from earthquakes greater than magnitude 6.5, with ranges 5.0 -5.75 and 5.75 - 6.5 contributing equally and earthquakes of magnitude between 3.75 and 5.0 contributing less. Hence including earthquakes in that latter range would not have changed the hazard significantly at this site.

The discussion given in Section 2.1 relative to the dominance of G-Expert 5's GM model for the BEHC and AMHC also applies. It is interesting to note that only for S-Experts 1,4 and 5's input was there a larger spread between G-Expert 5's BEHC per S-Expert than the other G-Experts' BEHC, than shown in Fig. 2.1.11. In no case was the spread as large as shown in Fig. 2.1.12. This is consistent with the significance of the contribution of smaller magnitude earthquakes to the hazard. For S-Experts 3,6,10,11 and 13 the spread between the G-Experts' BEHCs is less than shown in Fig. 2.1.11 and is more typical of that observed at rock sites when the host zone dominates the hazard. In this case the spread between the G-Experts' BEHCs per S-Expert is similar to that shown in Fig. 2.3.12.

TABLE 2.3.1

MOST IMPORTANT ZONES PER S-EXPERT FOR COMANCHE PEAK

SITE SOIL CATEGORY ROCK

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 8	ZONE ID:	ZONE 5	ZONE 9	ZONE 10	ZONE 1	ZONE 5	ZONE 9	ZONE 8	ZONE 1
		% CONT.:	45.	35.	8.	6.	45.	44.	7.	3.
2	COMP. ZO	ZONE ID:	ZONE 18	ZONE 5	COMP. ZON	ZONE 2	ZONE 18	COMP. ZON	ZONE 2	ZONE 1
		% CONT.:	52.	27.	17.	3.	57.	42.	1.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 14	ZONE 10	ZONE 13	COMP. ZON	ZONE 10	ZONE 14	ZONE 13
		% CONT.:	41.	34.	13.	9.	93.	3.	2.	2.
4	COMP. ZO	ZONE ID:	ZONE 4	COMP. ZON	ZONE 1	ZONE 3	ZONE 4	COMP. ZON	ZONE 1	ZONE 2
		% CONT.:	94.	3.	2.	1.	95.	5.	0.	0.
5	COMP. ZO	ZONE ID:	ZONE 17	ZONE 15	COMP. ZON	ZONE 18	ZONE 15	ZONE 17	COMP. ZON	ZONE 11
		% CONT.:	76.	21.	2.	1.	61.	30.	9.	0.
6	COMP. ZO	ZONE ID:	ZONE 25	COMP. ZON	ZONE 18	ZONE 17	COMP. ZON	ZONE 25	ZONE 18	ZONE 17
		% CONT.:	48.	32.	8.	6.	76.	21.	2.	0.
7	ZONE 1	ZONE ID:	ZONE 6	ZONE 30	ZONE 1	ZONE 35	ZONE 6	ZONE 1	ZONE 30	ZONE 2 =
		% CONT.:	72.	14.	8.	4.	83.	13.	3.	1.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 29	ZONE 12A	ZONE 32	ZONE 19 =	ZONE 29	ZONE 12A	ZONE 13
		% CONT.:	78.	18.	3.	0.	98.	2.	0.	0.
11	CZ = ZON	ZONE ID:	CZ = ZONE	ZONE 15	ZONE 11	ZONE 16	CZ = ZONE	ZONE 15	ZONE 11	ZONE 16
		% CONT.:	68.	18.	7.	4.	95.	4.	1.	0.
12	ZONE 4 =	ZONE ID:	ZONE 3	ZONE 8	ZONE 15	ZONE 6	ZONE 3	ZONE 8	ZONE 15	ZONE 1
		% CONT.:	73.	22.	2.	1.	95.	4.	0.	0.
13	CZ 16	ZONE ID:	ZONE 5	CZ 16	ZONE 1	CZ 15	. CZ 16	CZ 15	ZONE 5	ZONE 1
		% CONT.:	39.	31.	20.	10.	52.	26.	19.	3.

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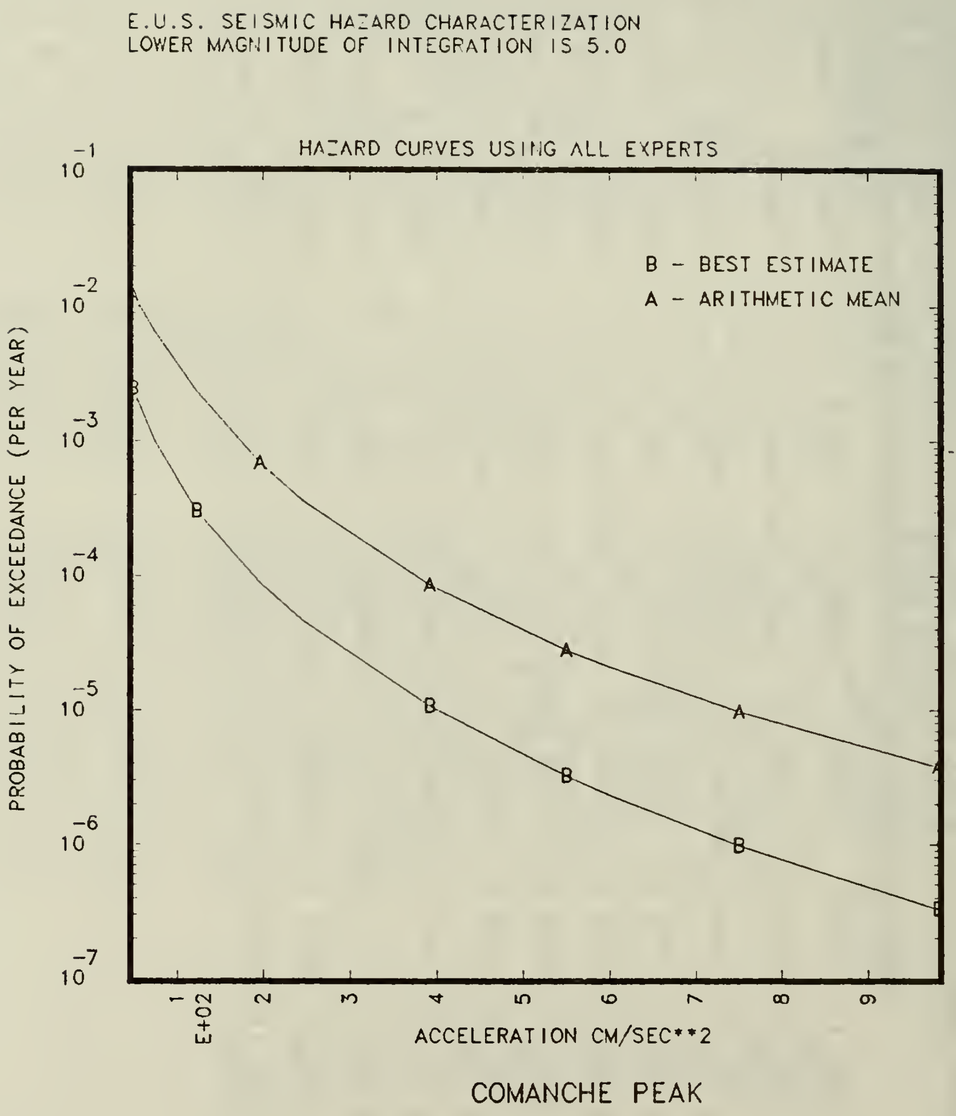

Figure 2.3.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Comanche Peak site.

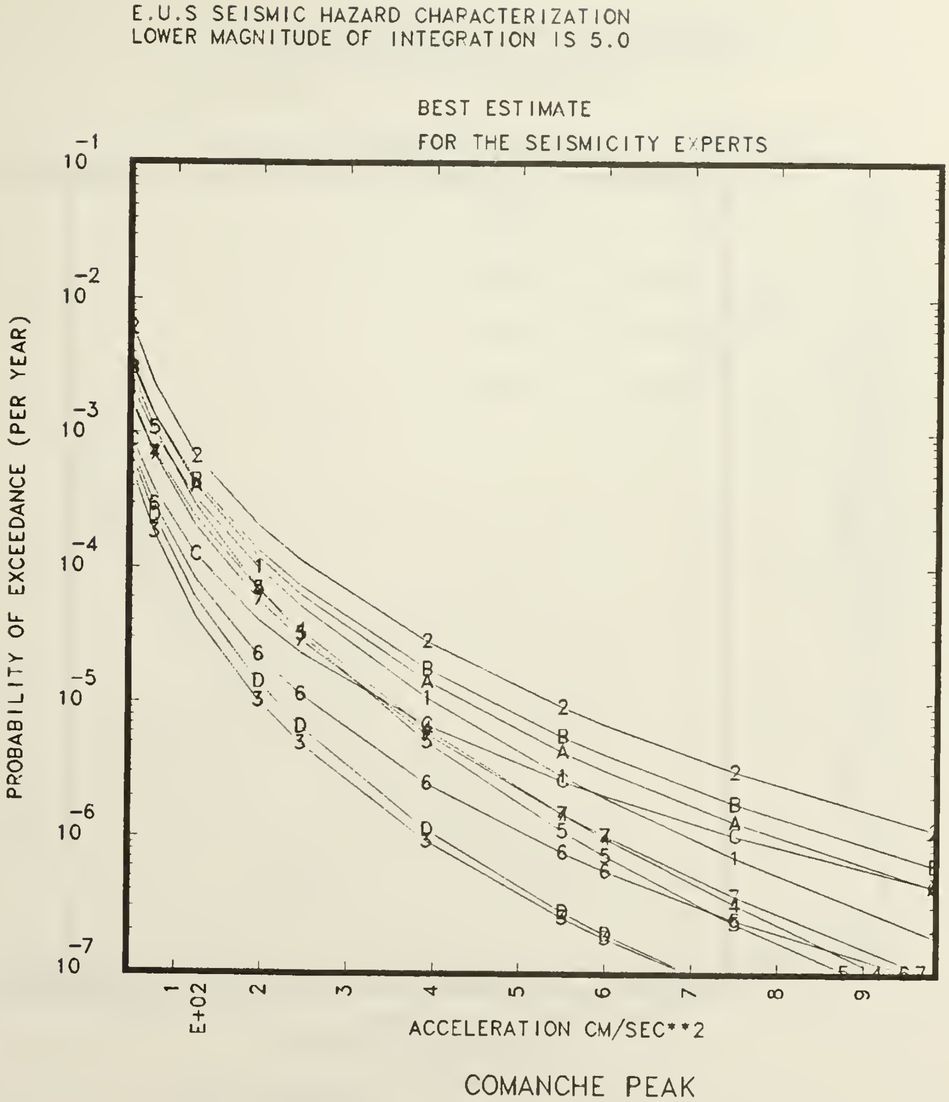

Figure 2.3.2 BEHCs per S-Expert combined over all G-Experts for the Comanche Peak site. Plot symbols given in Table 2.0.

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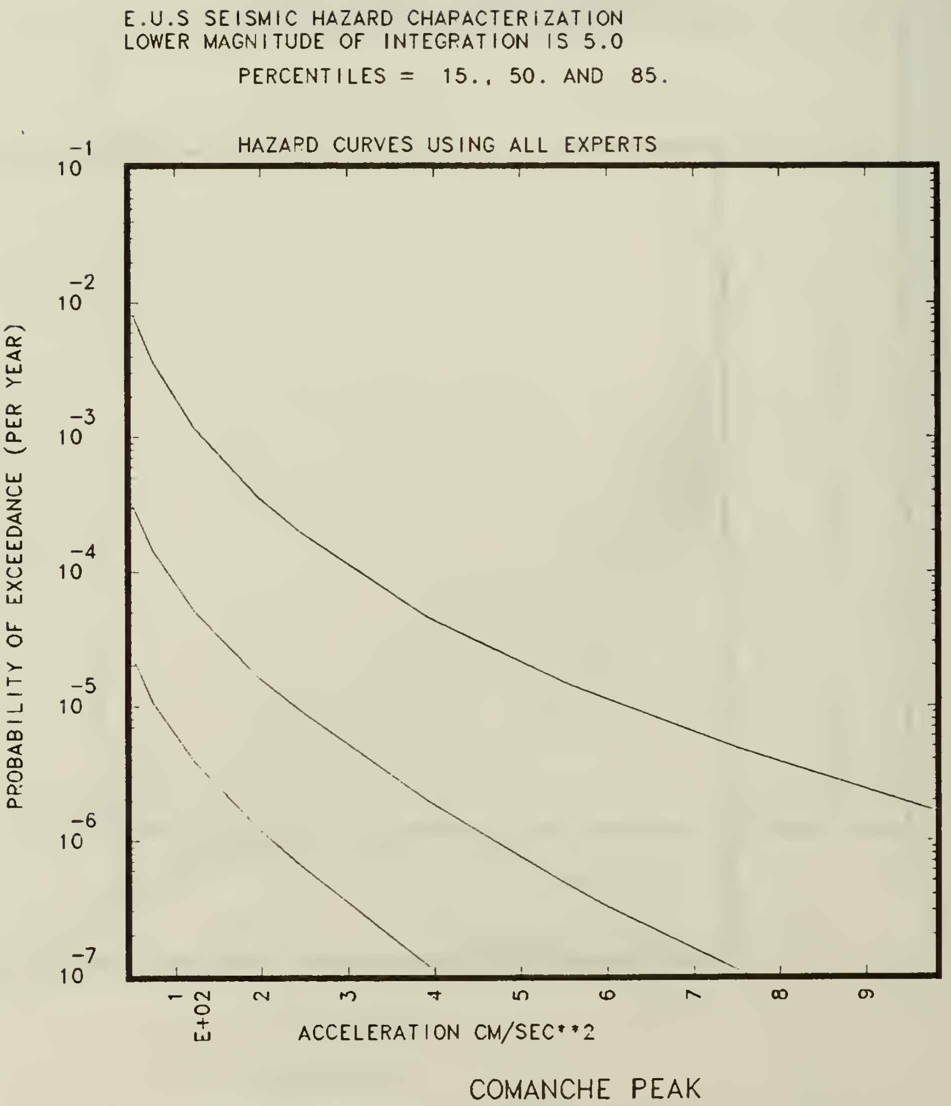

Figure 2.3.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Comanche Peak site.

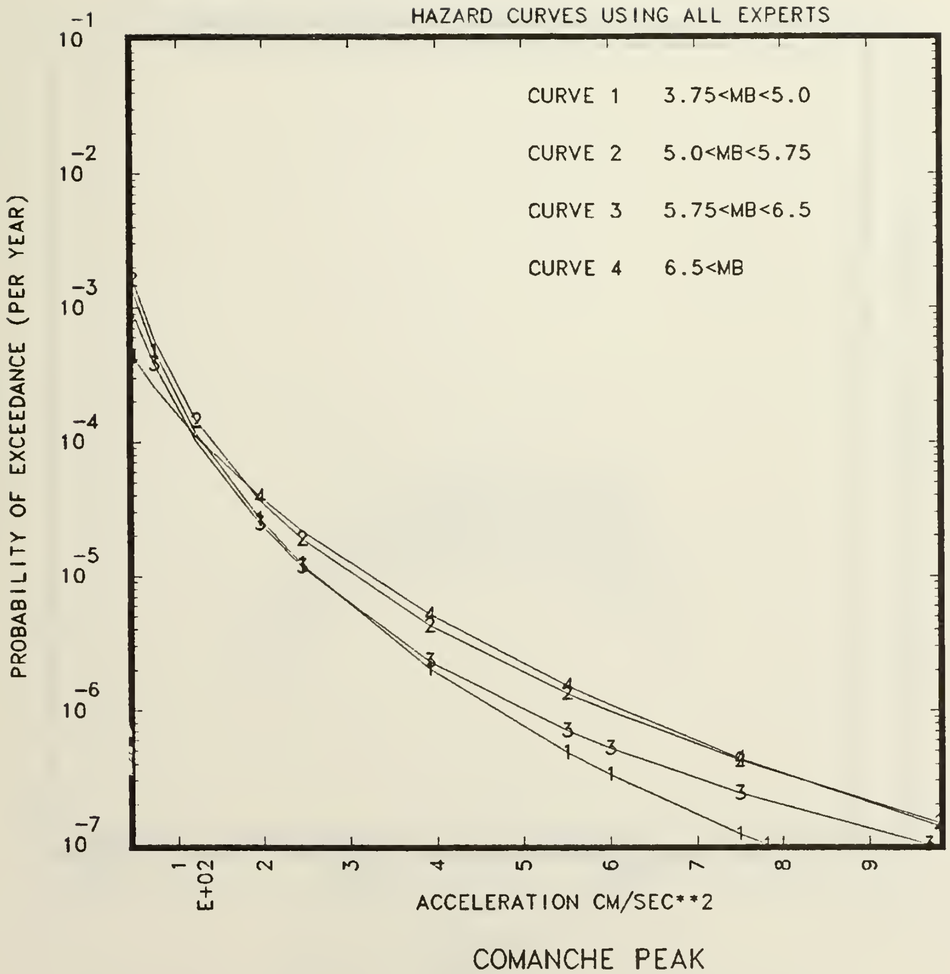

Figure 2.3.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Comanche Peak site.

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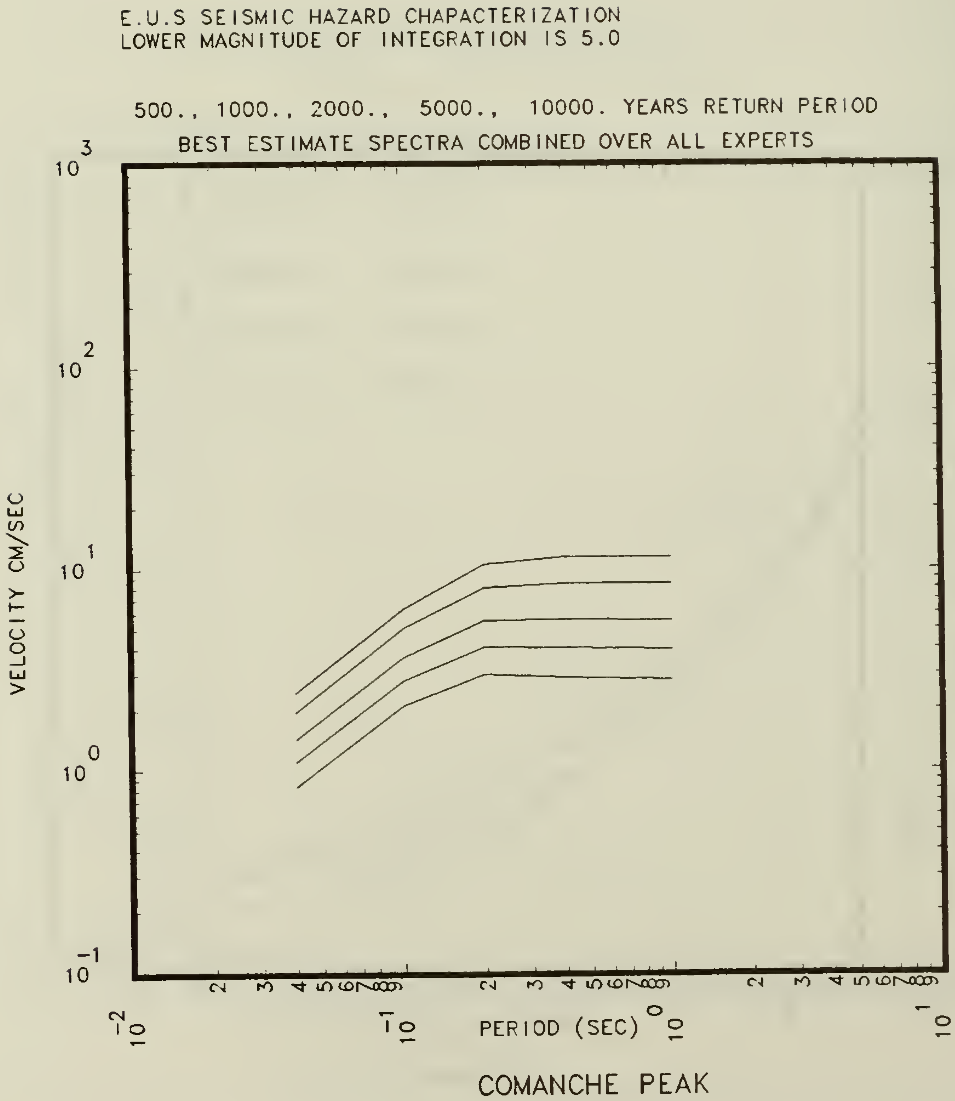

Figure 2.3.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Comanche Peak site.

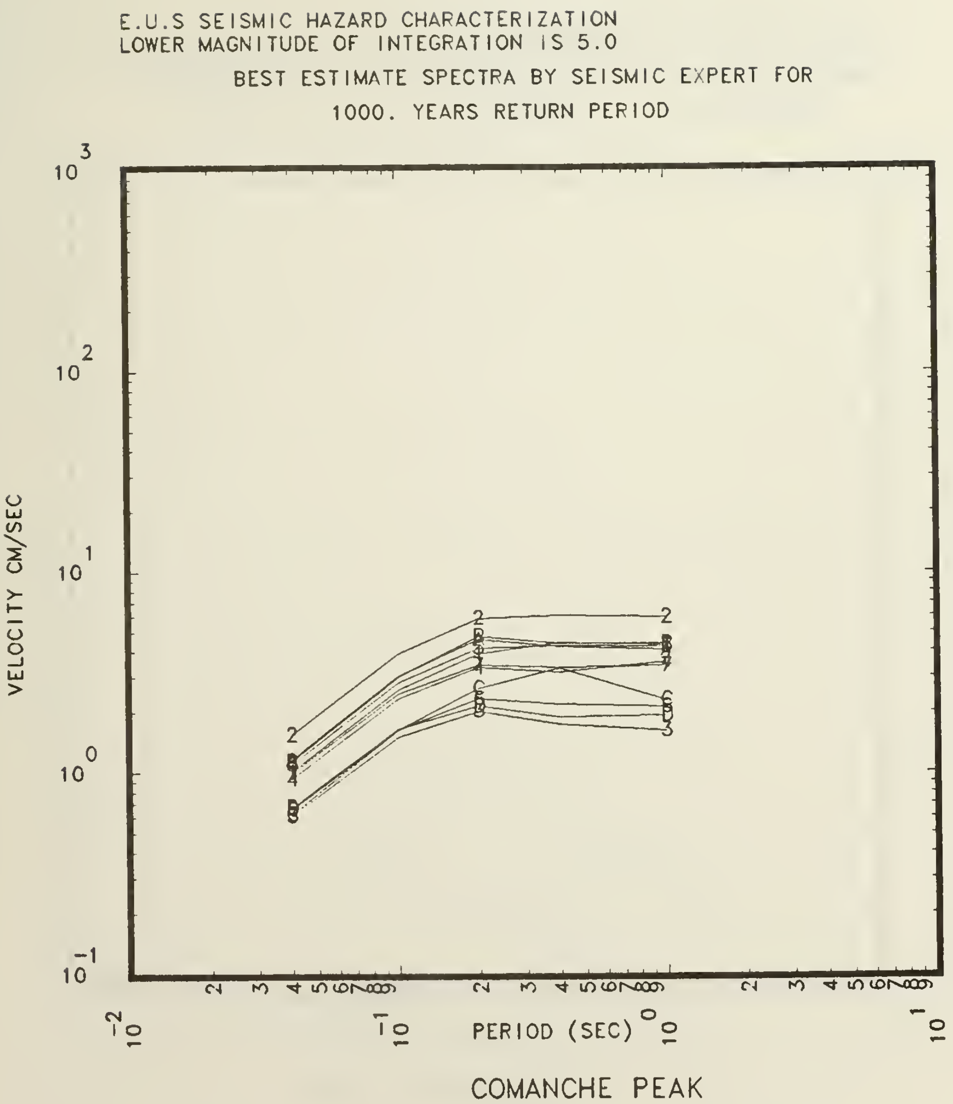

Figure 2.3.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Comanche Peak site. Plot symbols are given in Table 2.0.

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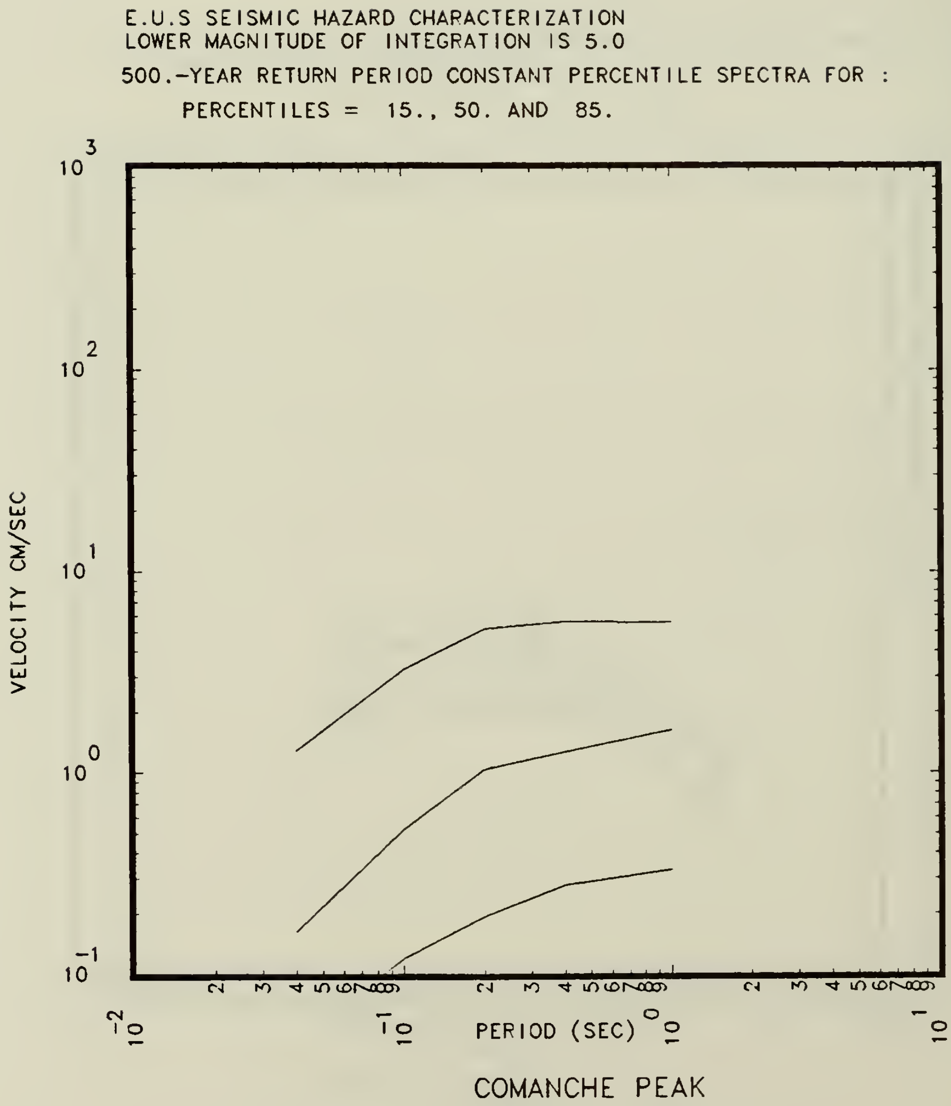

Figure 2.3.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Comanche Peak site.

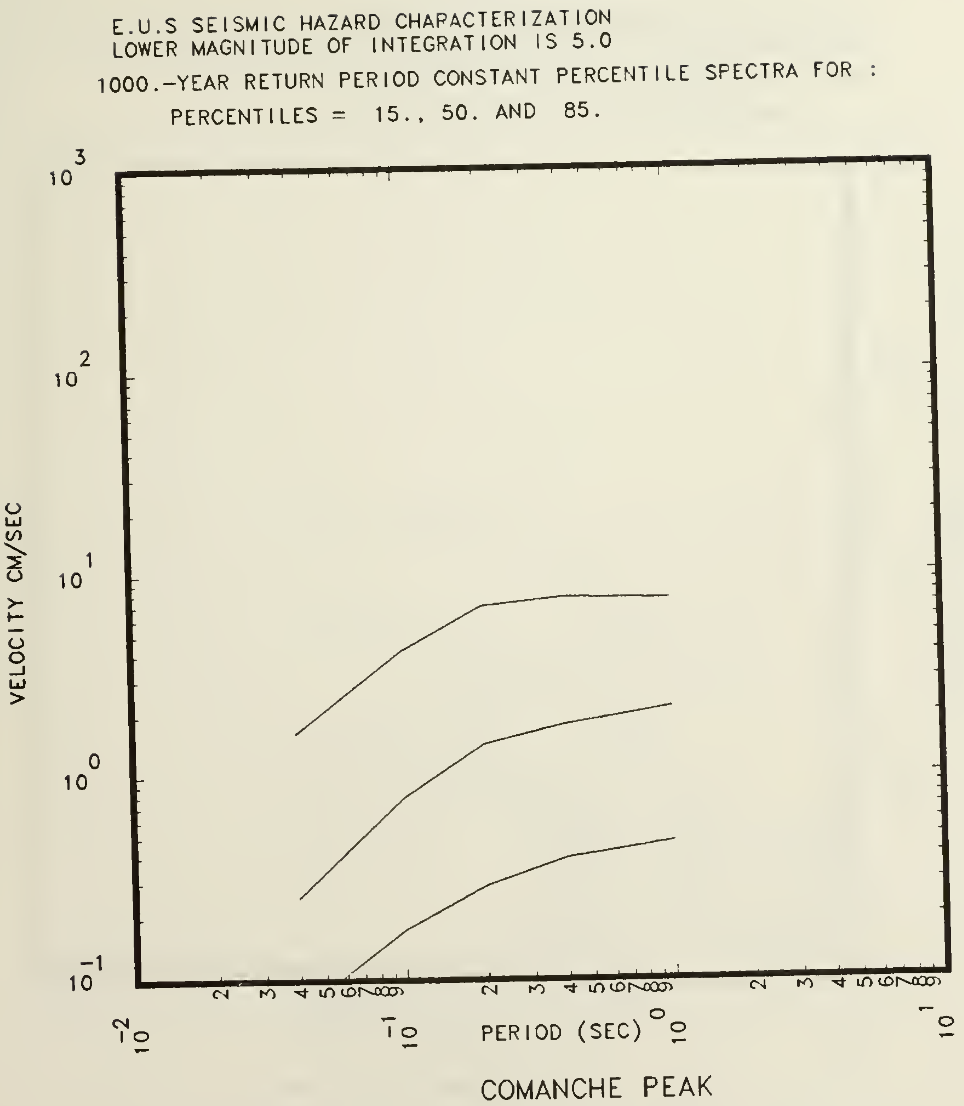

Figure 2.3.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Comanche Peak site.

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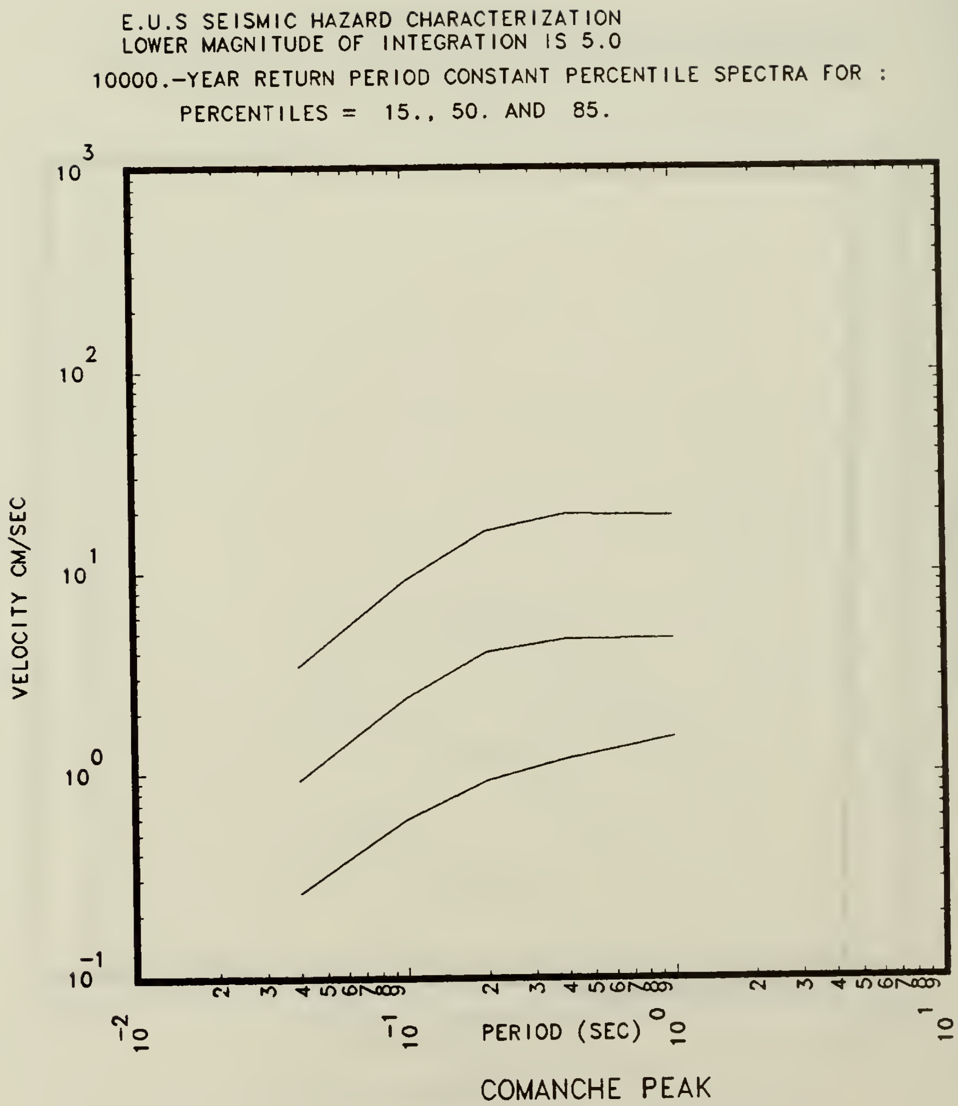

Figure 2.3.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Comanche Peak site.

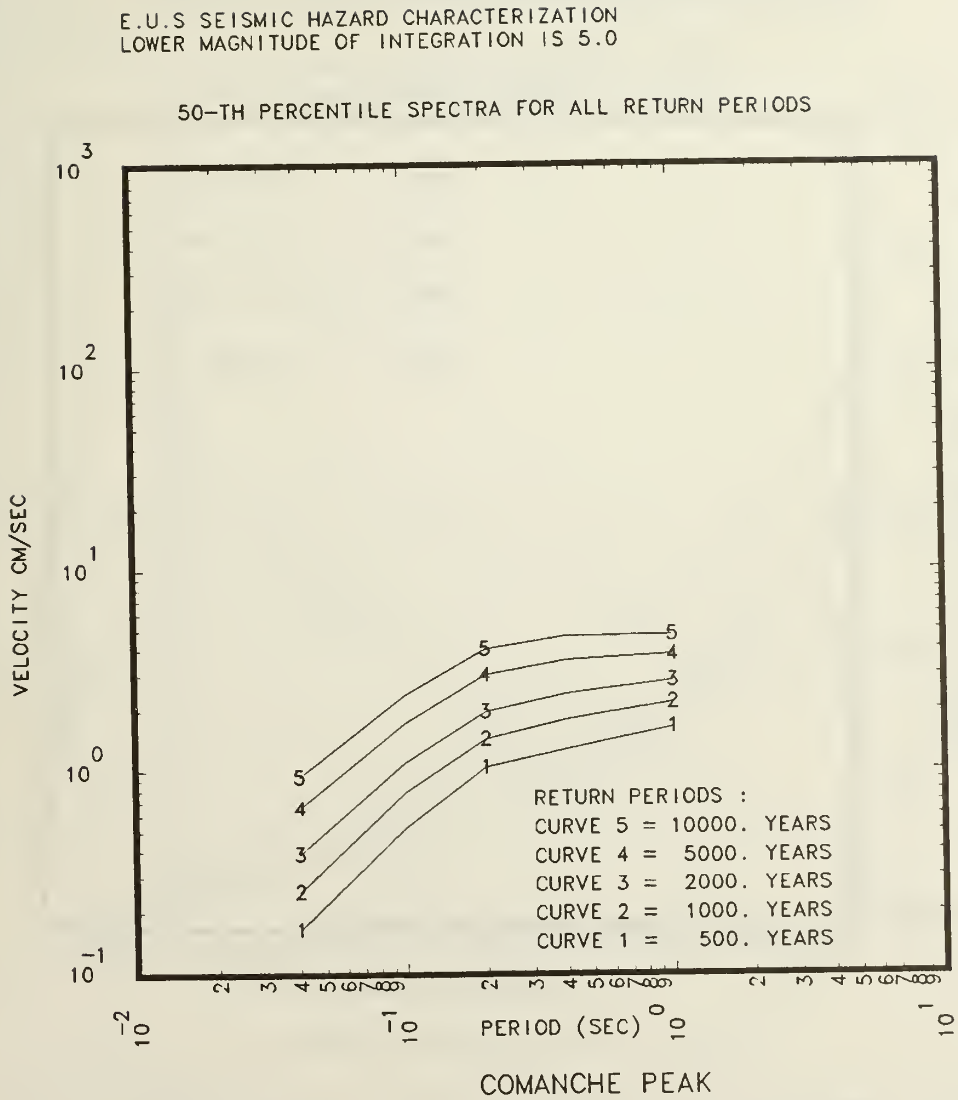

Figure 2.3.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Comanche Peak site.

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CONTRIBUTION TO THE HAZARD FOR PGA
FROM THE EARTHQUAKES IN 4 DISTANCE RANGES

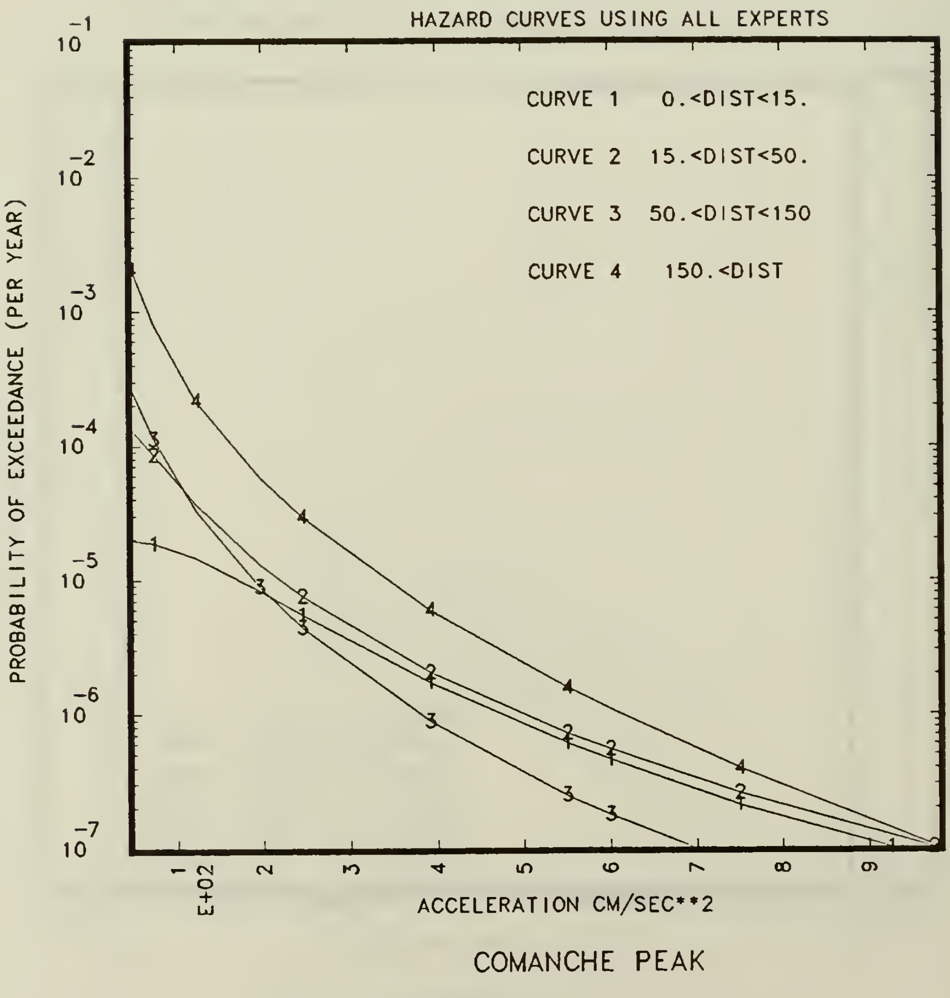
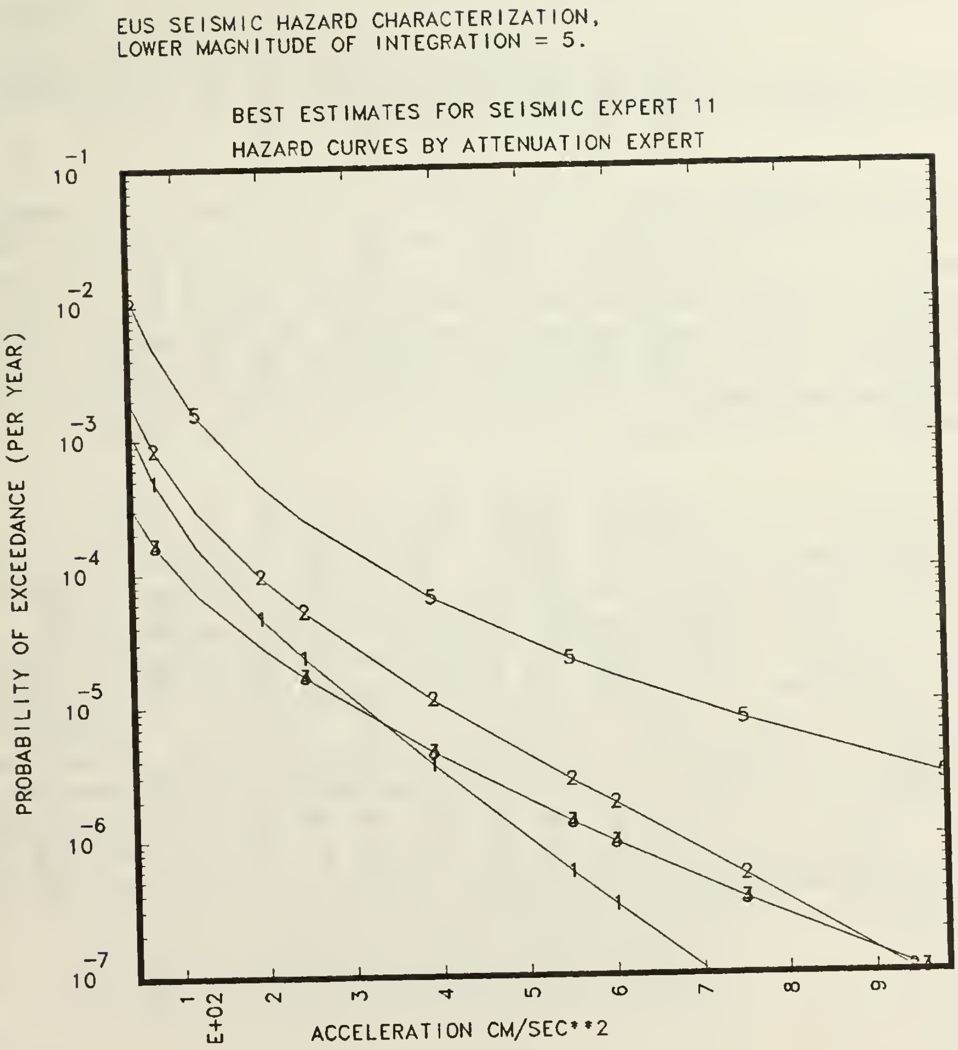


Figure 2.3.11 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated distance ranges for the Comanche Peak site.



COMANCHE PEAK

Figure 2.3.12 Comparison of the BEHCs per G-Expert for S-Expert 11's input for the Comanche Peak site. The spread between the G-Experts' BEHCs is typical for rock sites when the dominant contributor to the hazard is from the region near the site.

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2.4 COOPER

Cooper was placed in the sand-1 (see table 1.4) category. It is located in region 4 (south central) and is represented by the symbol "4" on the location map (Fig. 1.1). The New Madrid zones play relatively important roles for several experts, but the New Madrid zones only dominate the hazard for two S-Experts. Table 2.4.1 and Figs. 2.4.1 to 2.4.10 give the results of the analysis for the site.

Figures 2.4.1 and 2.4.3 show typical results. The AMHC is slightly higher than the 85th percentile, (see Fig. 2.4.3).

Figure 2.4.2 indicates that the diversity of opinion, as measured by the spread of the BEHC for all S-Experts, is typical.

Figure 2.4.4 shows the relative contribution of earthquakes in several ranges of magnitude. Up to approximately 0.2g, the hazard is dominated by small earthquakes. Thus if earthquakes in the range of 3.75 to 5. were included in the analysis the hazard would be increased and multiplied by a factor of 5 in the 0.05g to 0.2g range. Beyond this value, the earthquakes in the lowest bin (magnitude 3.75 to 5) do not contribute significantly to the total hazard but small to medium earthquakes ($5.0 \leq m_b < 5.75$) dominate the hazard. Large earthquakes do not contribute significantly to the total hazard.

The spread between the G-Experts BEHCs per S-Expert, particularly between G-Expert 5's BEHC and the other G-Experts' BEHCs per S-Expert is much smaller for a soil site like Cooper than a rock site for the reasons discussed in Section 2.1. Typically, the spread is similar to the spread shown in Fig. 2.4.11. However, for S-Experts 1 and 5 where the somewhat distant New Madrid zone dominates the hazard the spread between the G-Experts BEHCs per S-Experts 1 and 5 is much larger as shown in Fig. 2.4.12. The lower attenuation rate of G-Experts 2 and 5's BE model becomes important and spreads out the G-Experts' BEHCs per S-Expert. It is also interesting to note that we see from Table 2.4.1 that for S-Experts 2 and 7 that the New Madrid zones made a significant (but not the dominate) contribution to the hazard. For S-Experts 2 and 7, the spread between the G-Experts' BEHCs is larger than that shown in Fig. 2.4.11 but less than that shown in Fig. 2.4.12.

TABLE 2.4.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR COOPER

SITE SOIL CATEGORY SAND-1

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 15	ZONE ID:	ZONE 9	ZONE 14	ZONE 10	ZONE 15	ZONE 9	ZONE 15	ZONE 14	ZONE 10
		% CONT.:	39.	31.	14.	10.	56.	31.	8.	4.
2	ZONE 15	ZONE ID:	ZONE 15	ZONE 18	COMP. ZON	ZONE 20	ZONE 15	ZONE 18	COMP. ZON	ZONE 1
		% CONT.:	51.	43.	5.	0.	71.	25.	4.	0.
3	ZONE 16	ZONE ID:	ZONE 16	ZONE 13	COMP. ZON	ZONE 12	ZONE 16	COMP. ZON	ZONE 13	ZONE 12
		% CONT.:	92.	3.	3.	2.	99.	1.	0.	0.
4	ZONE 1	ZONE ID:	ZONE 1	ZONE 4	ZONE 13	ZONE 3	ZONE 1	ZONE 4	COMP. ZON	ZONE 13
		% CONT.:	78.	21.	0.	0.	97.	3.	0.	0.
5	COMP. ZO	ZONE ID:	ZONE 15	COMP. ZON	ZONE 17	ZONE 14	ZONE 15	COMP. ZON	ZONE 13	ZONE 14
		% CONT.:	83.	12.	3.	2.	76.	24.	0.	0.
6	ZONE 27	ZONE ID:	ZONE 27	ZONE 17	ZONE 18	COMP. ZON	ZONE 27	ZONE 17	ZONE 18	COMP. ZON
		% CONT.:	72.	14.	6.	4.	98.	1.	1.	0.
7	ZONE 31	ZONE ID:	ZONE 6	ZONE 31	ZONE 2 =	ZONE 5	ZONE 31	ZONE 6	ZONE 2 =	ZONE 1
		% CONT.:	61.	36.	2.	1.	61.	38.	0.	0.
10	ZONE 32	ZONE ID:	ZONE 32	ZONE 19 =	ZONE 12A	ZONE 13	ZONE 32	ZONE 19 =	ZONE 12A	ZONE 13
		% CONT.:	95.	4.	1.	0.	99.	1.	0.	0.
11	ZONE 17	ZONE ID:	ZONE 17	CZ = ZONE	ZONE 11	ZONE 10	ZONE 17	CZ = ZONE	ZONE 11	ZONE 9
		% CONT.:	80.	15.	2.	2.	97.	3.	0.	0.
12	ZONE 7	ZONE ID:	ZONE 7	ZONE 6	ZONE 15	ZONE 3	ZONE 7	ZONE 15	ZONE 6	ZONE 1
		% CONT.:	99.	1.	0.	0.	100.	0.	0.	0.
13	ZONE 18	ZONE ID:	ZONE 18	CZ 15	ZONE 5	ZONE 6	ZONE 18	CZ 15	ZONE 5	ZONE 1
		% CONT.:	86.	12.	3.	0.	82.	18.	0.	0.

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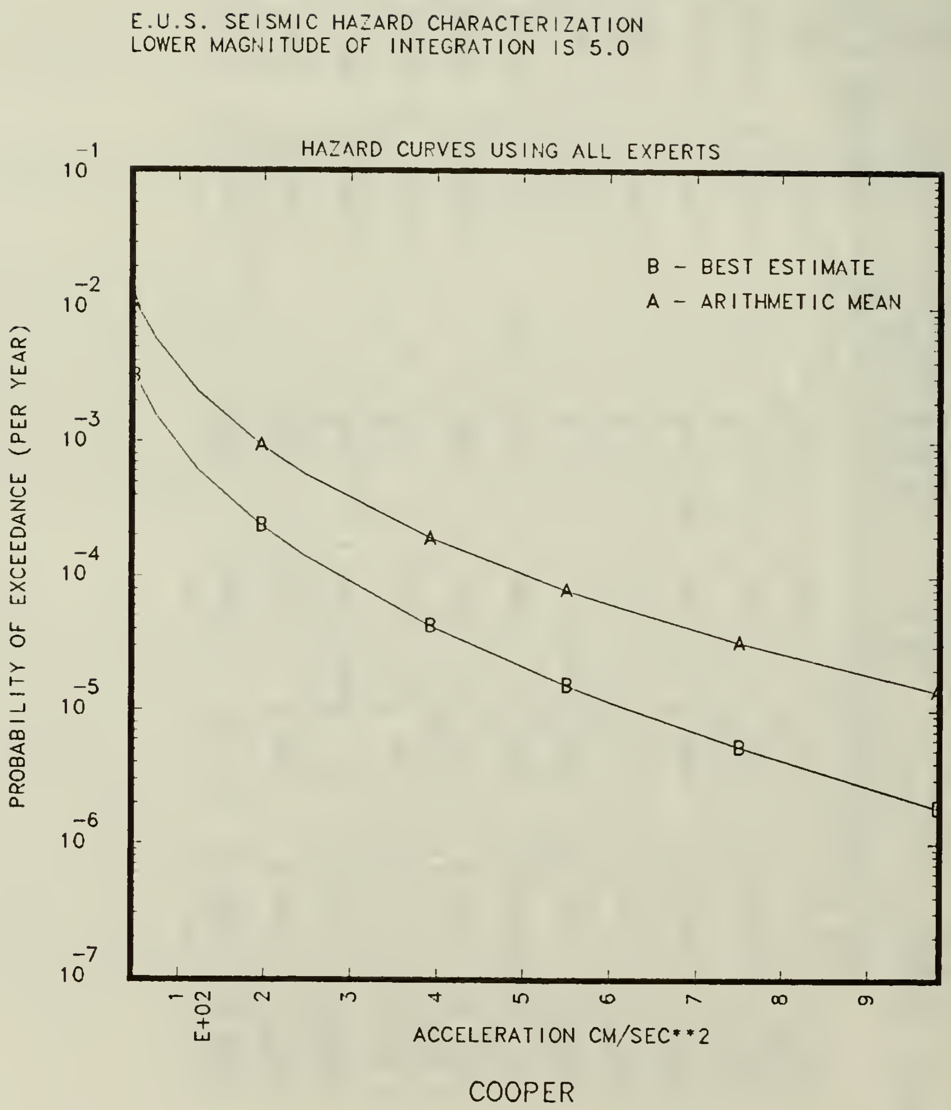

Figure 2.4.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Cooper site.

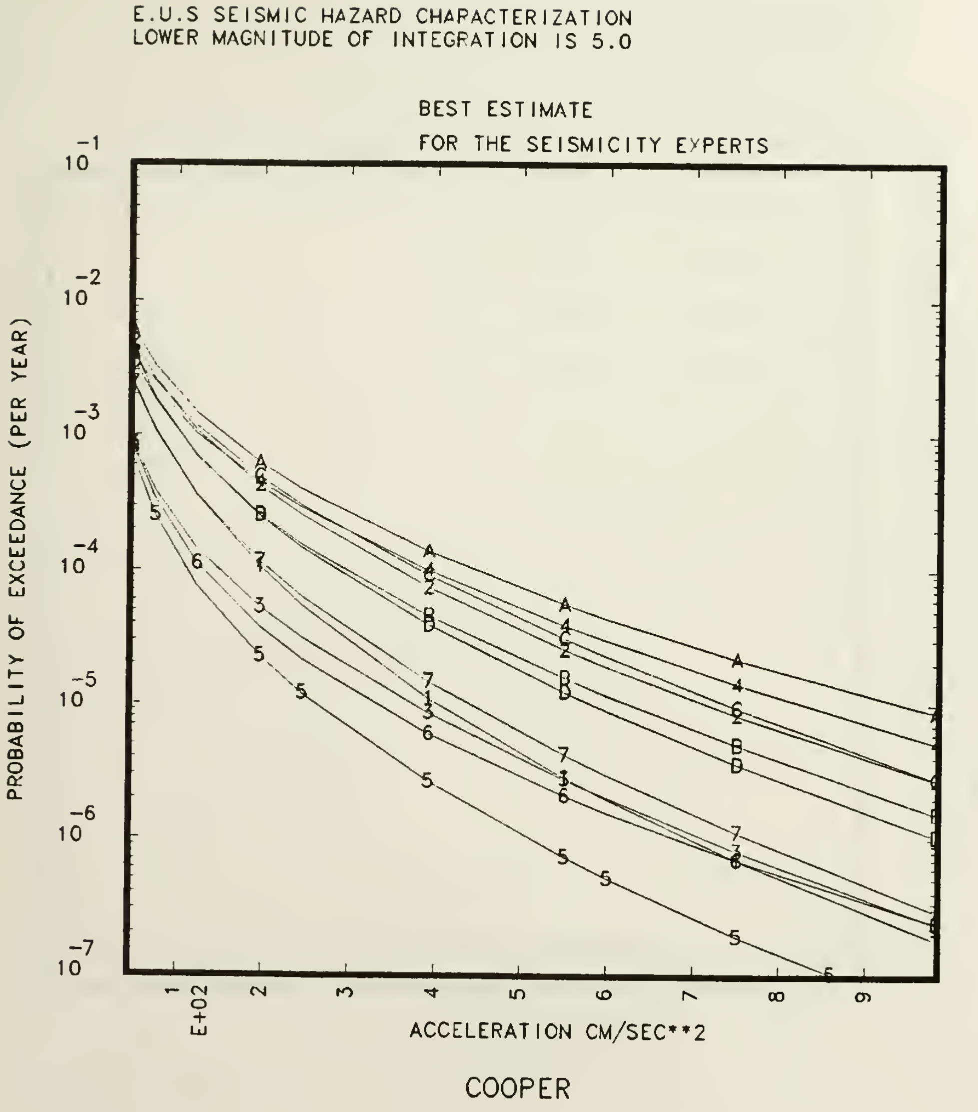

Figure 2.4.2 BEHCs per S-Expert combined over all G-Experts for the Cooper site. Plot symbols given in Table 2.0.

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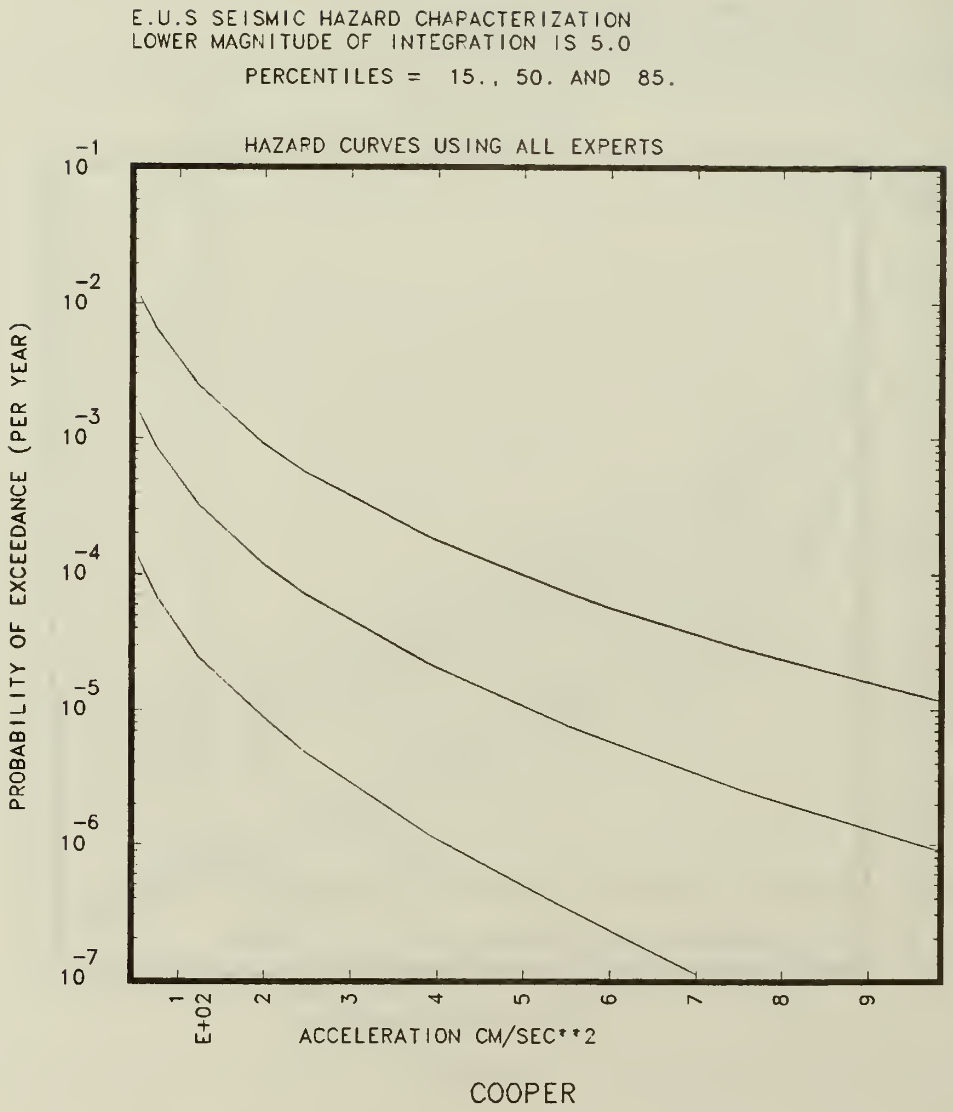

Figure 2.4.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Cooper site.

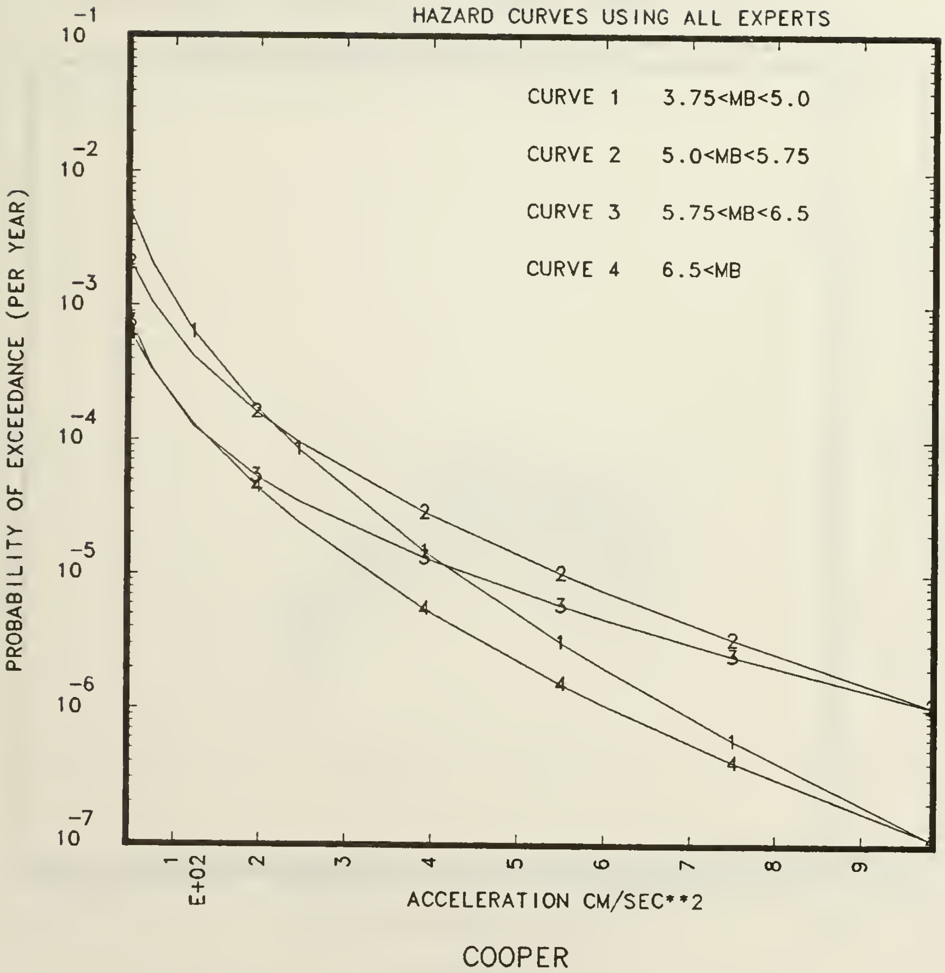

Figure 2.4.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Cooper site.

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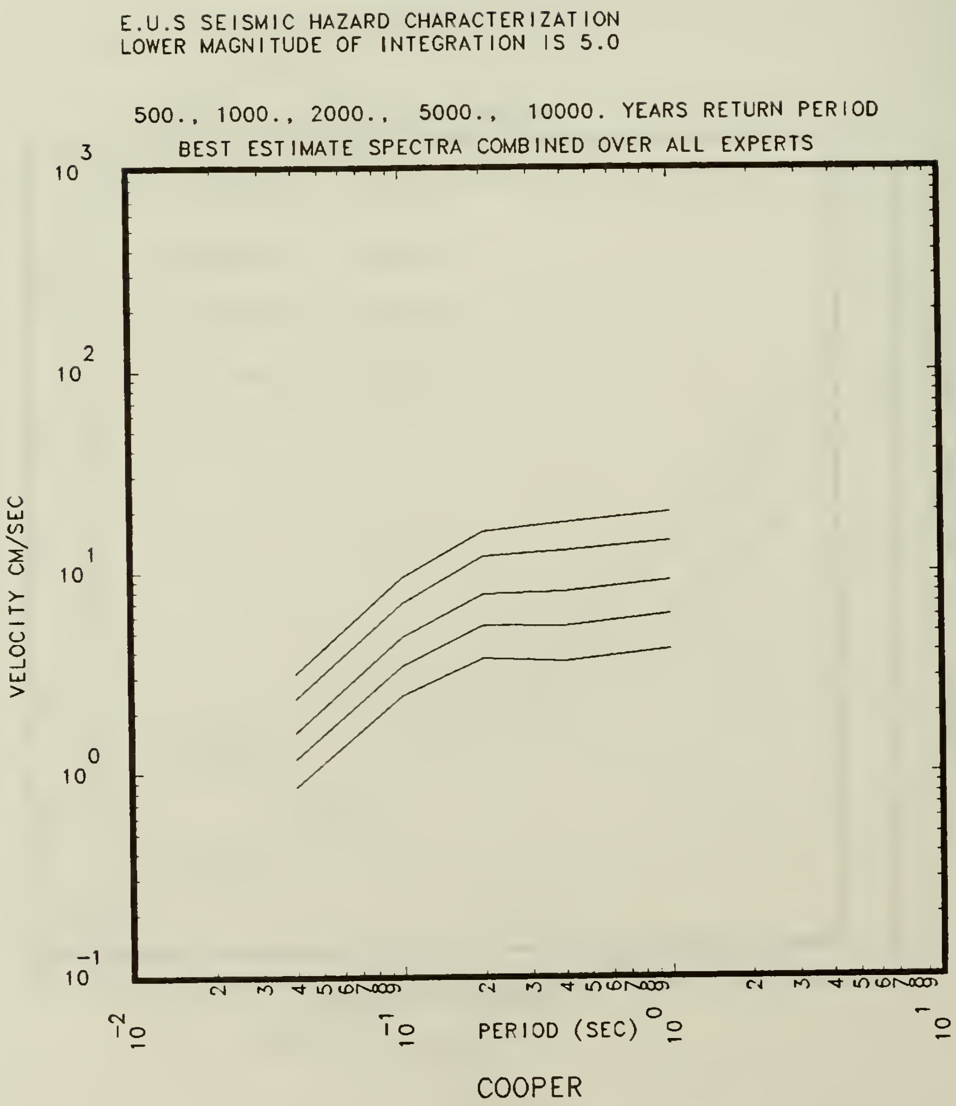

Figure 2.4.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Cooper site.

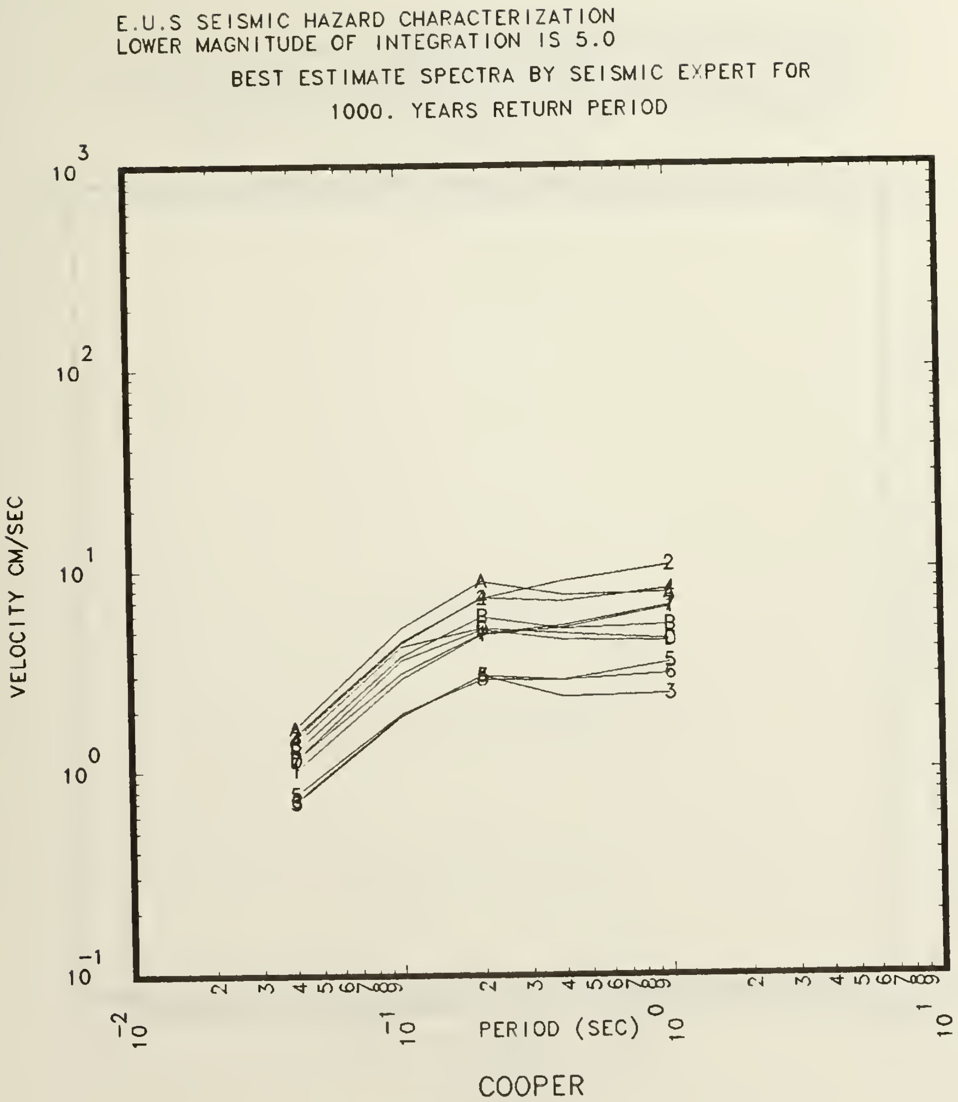

Figure 2.4.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Cooper site. Plot symbols are given in Table 2.0.

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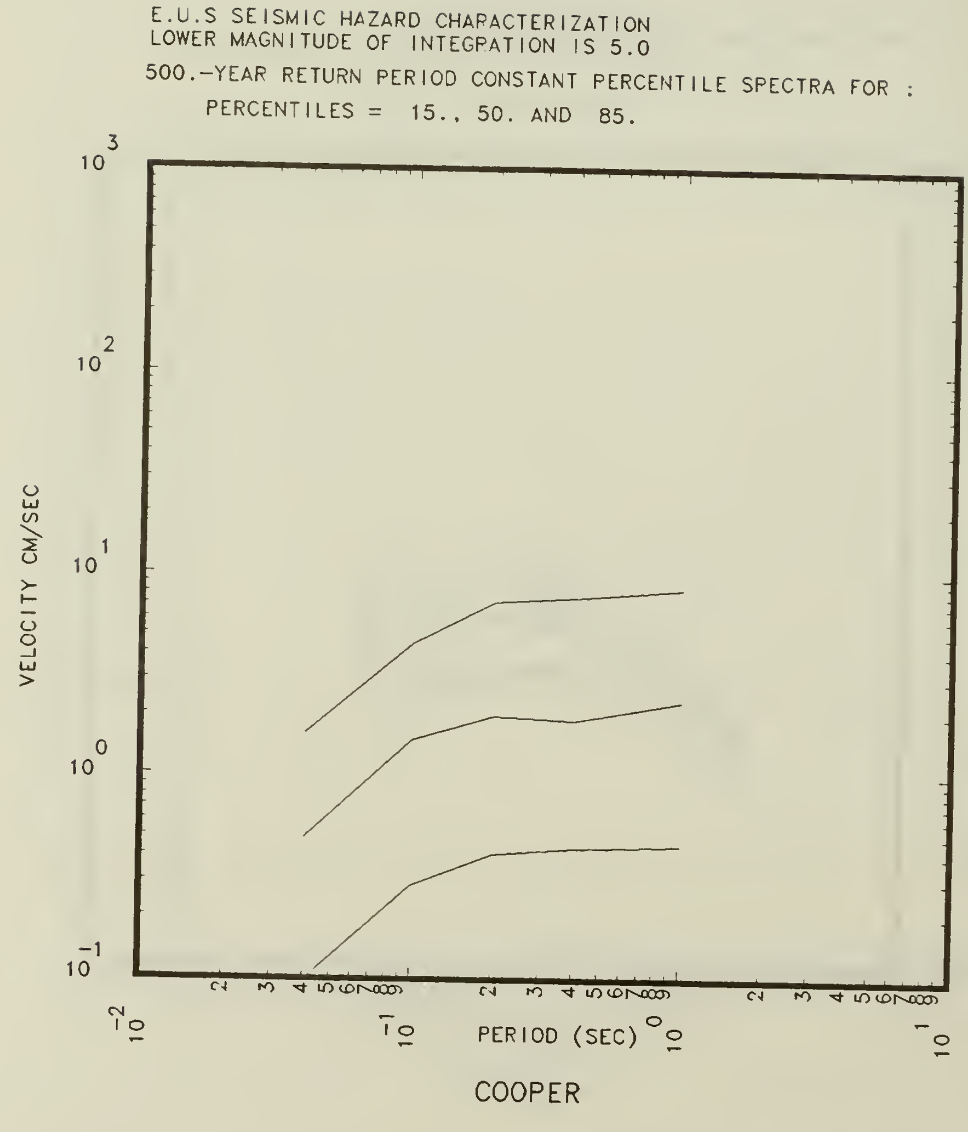

Figure 2.4.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Cooper site.

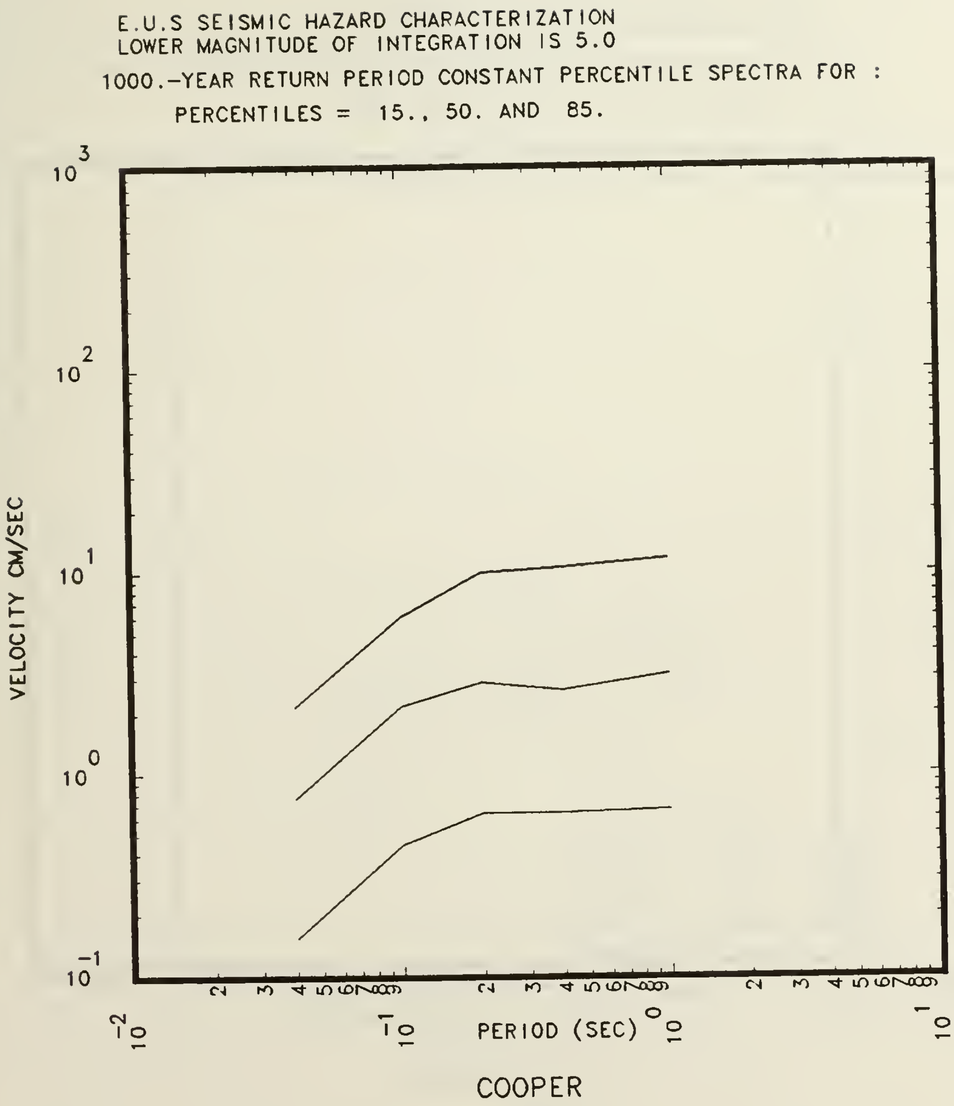

Figure 2.4.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Cooper site.

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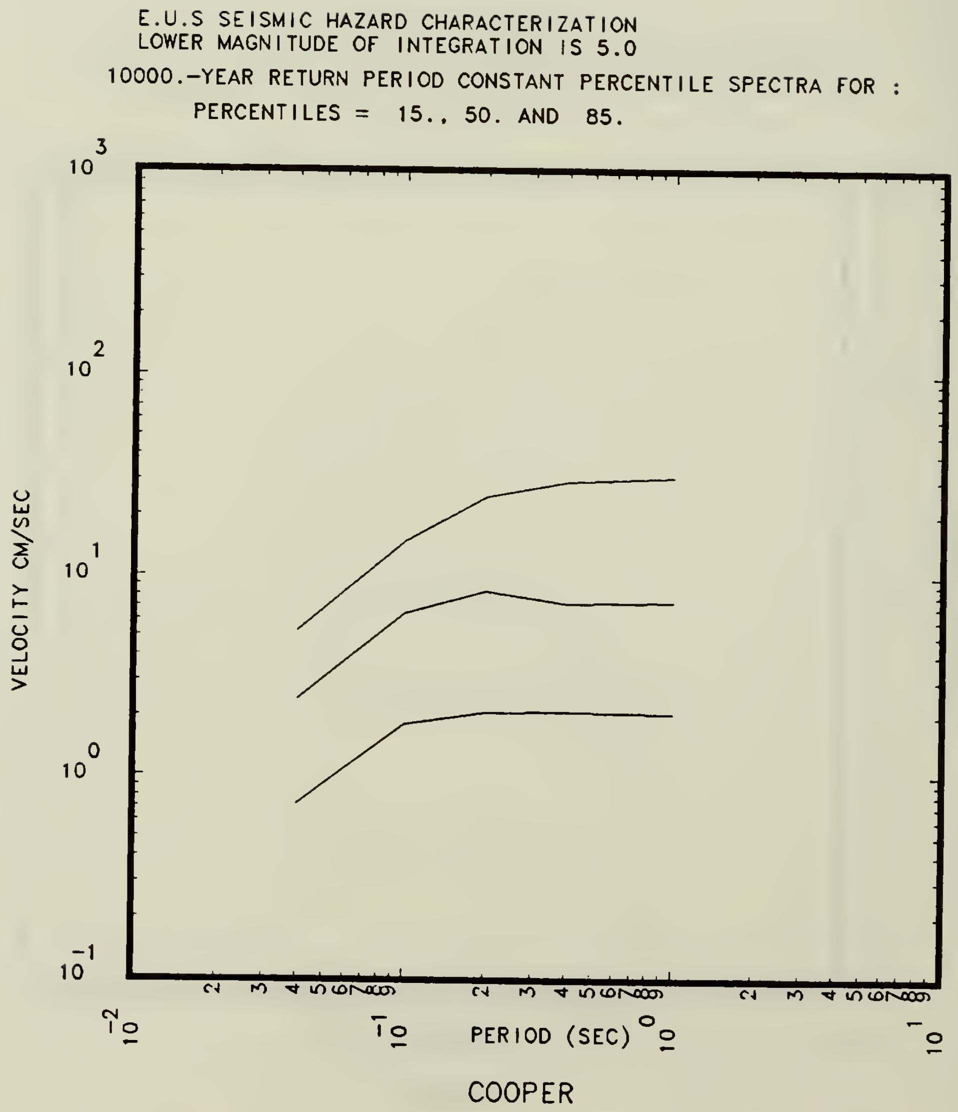

Figure 2.4.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Cooper site.

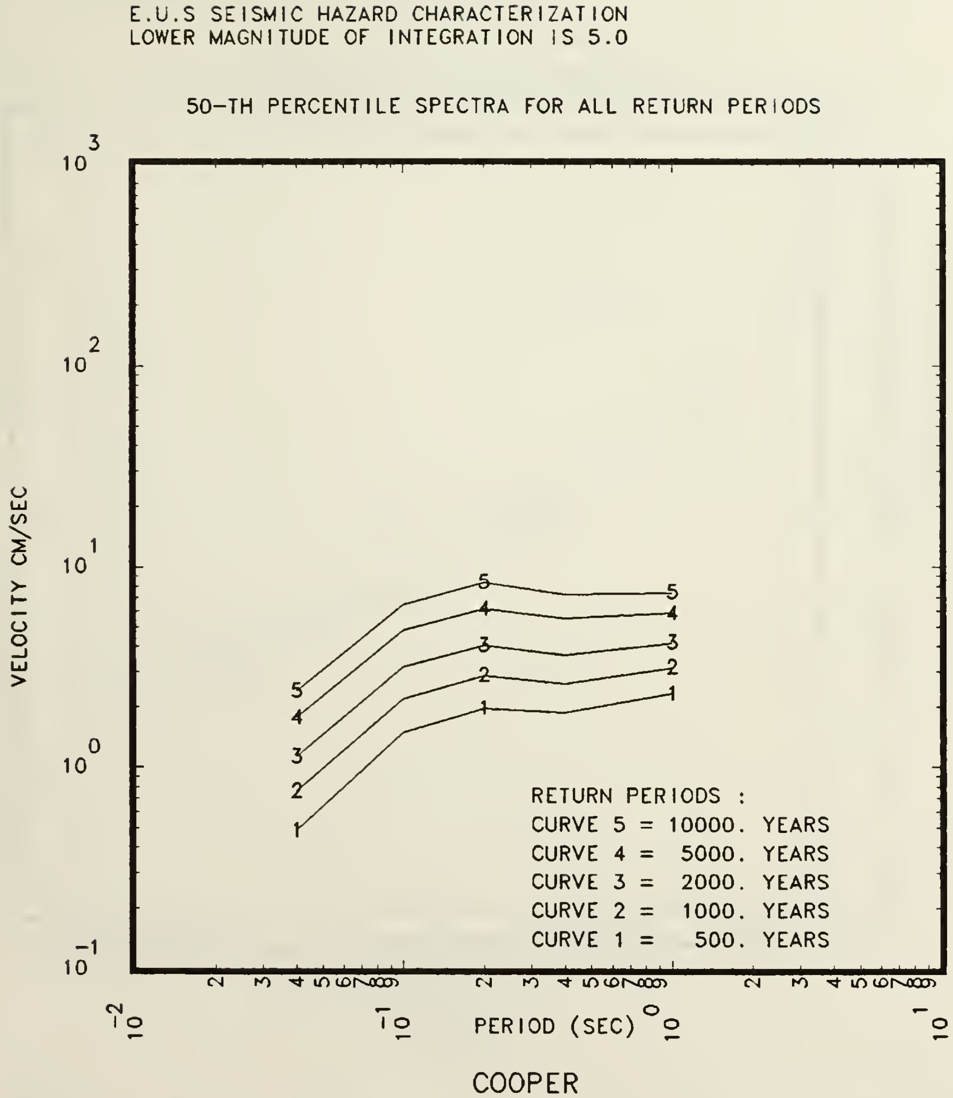

Figure 2.4.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Cooper site.

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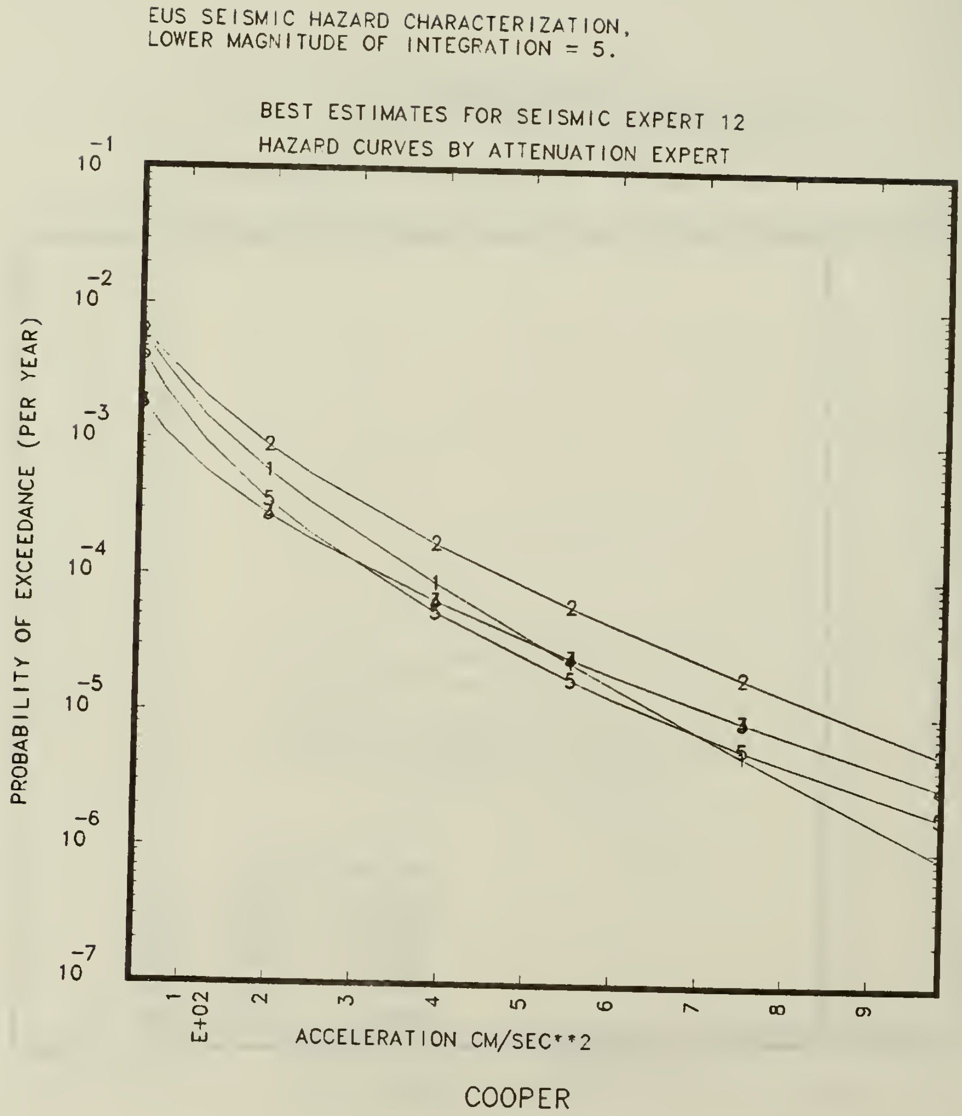

Figure 2.4.11 Comparison of the BEHCs per G-Expert for S-Expert 12's input for the Cooper site. The spread between the G-Experts' BEHCs is typical for the case when the S-Expert's input results in nearby earthquakes being the dominant contributor to the hazard at a soil site.

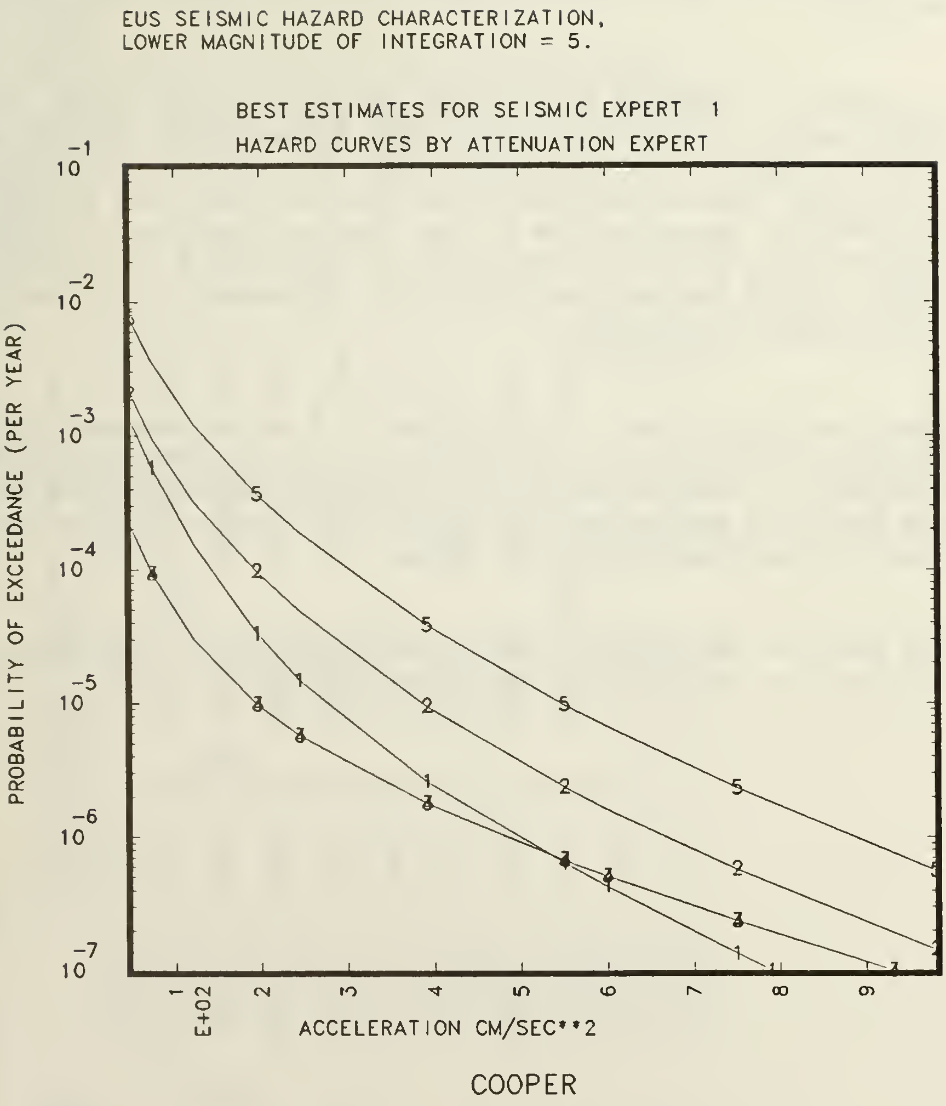

Figure 2.4.12 Comparison of the BEHCs per G-Expert for S-Expert 1's input for the Cooper site. The spread between the G-Experts' BEHCs is typical for the cases when the S-Expert's input results in distant large magnitude earthquakes as the dominant contributor to the hazard at a soil site.

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2.5 CRYSTAL RIVER

Crystal River is a rock site and is represented by the symbol "5" in Fig. 1.1. Table 2.5.1 and Figs. 2.5.1 to 2.5.10 give the results of the analysis for this site. The AMHC is higher than the 85th percentile and the BEHC is between the 50th and the 85th percentile (see Fig. 2.5.3). This indicates the presence of some outlier curves in the simulation. Table 2.5.1 shows that for most S-Experts, the Crystal River site is located inside a complementary zone, with a relatively low upper magnitude cutoffs and low occurrence rates. Thus the dominant zones are distant zones which have high rates of occurrence and higher upper magnitude cutoffs such as the Charleston zone. Indeed, the hazard comes for its most part from areas located 150 km or more from the site.

S-Expert 12 (symbol "C") appears to be a low outlier in Fig. 2.2.2. This is because for this expert, the Crystal River site is located in a zone (zone 26) which has a best estimate upper magnitude cutoff of 5.0 (see Table B12.1 in Appendix B), thus the first zones which contribute anything are already distant enough that the ground motion at the site be significantly attenuated, since the analysis only includes earthquakes of magnitude 5.0 and above. S-Expert 11's BEHC is high because the site falls in S-Expert 11's zone 8 which includes the Charleston earthquakes.

Fig. 2.5.4 shows that the biggest contribution is from earthquakes greater than magnitude 6.5, with ranges 5.0 -5.75 and 5.75 - 6.5 contributing much less and earthquakes of magnitude between 3.75 and 5.0 contributing only very little. Hence including earthquakes in that latter range would not have changed the hazard significantly at this site.

The discussion given in Sections 2.1 and 2.3 relative to the dominance of G-Expert 5's GM model for the BEHC and AMHC also applies.

TABLE 2.5.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR CRYSTAL RIVER

SITE SOIL CATEGORY ROCK

S-XPT NUM.	MOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 1	ZONE ID: % CONT.:	ZONE 1 86.	ZONE 2 13.	ZONE 3 1.	ZONE 4 0.	ZONE 1 99.	ZONE 2 1.	ZONE 3 0.	ZONE 4 0.
2	COMP. ZO	ZONE ID: % CONT.:	ZONE 30 84.	COMP. ZON 14.	ZONE 29 1.	ZONE 27 1.	ZONE 30 73.	COMP. ZON 27.	ZONE 29 0.	ZONE 27 0.
3	COMP. ZO	ZONE ID: % CONT.:	COMP. ZON 64.	ZONE 9 30.	ZONE 8A 3.	ZONE 5 2.	COMP. ZON 97.	ZONE 9 3.	ZONE 8A 0.	ZONE 8 0.
4	ZONE 25	ZONE ID: % CONT.:	ZONE 10 77.	ZONE 25 12.	ZONE 9 7.	ZONE 8 3.	ZONE 25 69.	ZONE 10 30.	COMP. ZON 1.	ZONE 26 0.
5	ZONE 21	ZONE ID: % CONT.:	ZONE 9 95.	ZONE 21 3.	ZONE 10 1.	ZONE 11 1.	ZONE 9 97.	ZONE 21 3.	COMP. ZON 0.	ZONE 8 0.
6	COMP. ZO	ZONE ID: % CONT.:	ZONE 13 70.	COMP. ZON 26.	ZONE 16 2.	ZONE 11 1.	ZONE 13 51.	COMP. ZON 48.	ZONE 16 1.	ZONE 11 0.
7	ZONE 1	ZONE ID: % CONT.:	ZONE 10 85.	ZONE 1 12.	ZONE 2 = 2.	ZONE 7 1.	ZONE 10 81.	ZONE 1 18.	ZONE 2 = 1.	ZONE 5 0.
10	ZONE 19	ZONE ID: % CONT.:	ZONE 19 = 90.	ZONE 15 7.	ZONE 28 1.	ZONE 4B 1.	ZONE 19 = 99.	ZONE 15 1.	ZONE 4B 0.	ZONE 26A 0.
11	ZONE 8	ZONE ID: % CONT.:	ZONE 8 98.	CZ = ZONE 2.	ZONE 6 0.	ZONE 7 0.	ZONE 8 100.	CZ = ZONE 0.	ZONE 6 0.	ZONE 7 0.
12	ZONE 26	ZONE ID: % CONT.:	ZONE 23A 93.	ZONE 24 3.	ZONE 19 2.	ZONE 23 1.	ZONE 23A 100.	ZONE 11 0.	ZONE 12 0.	ZONE 13 0.
13	CZ 16	ZONE ID: % CONT.:	ZONE 9 49.	CZ 16 44.	ZONE 8 3.	CZ 17 2.	CZ 16 69.	ZONE 9 19.	CZ 15 12.	ZONE 8 0.

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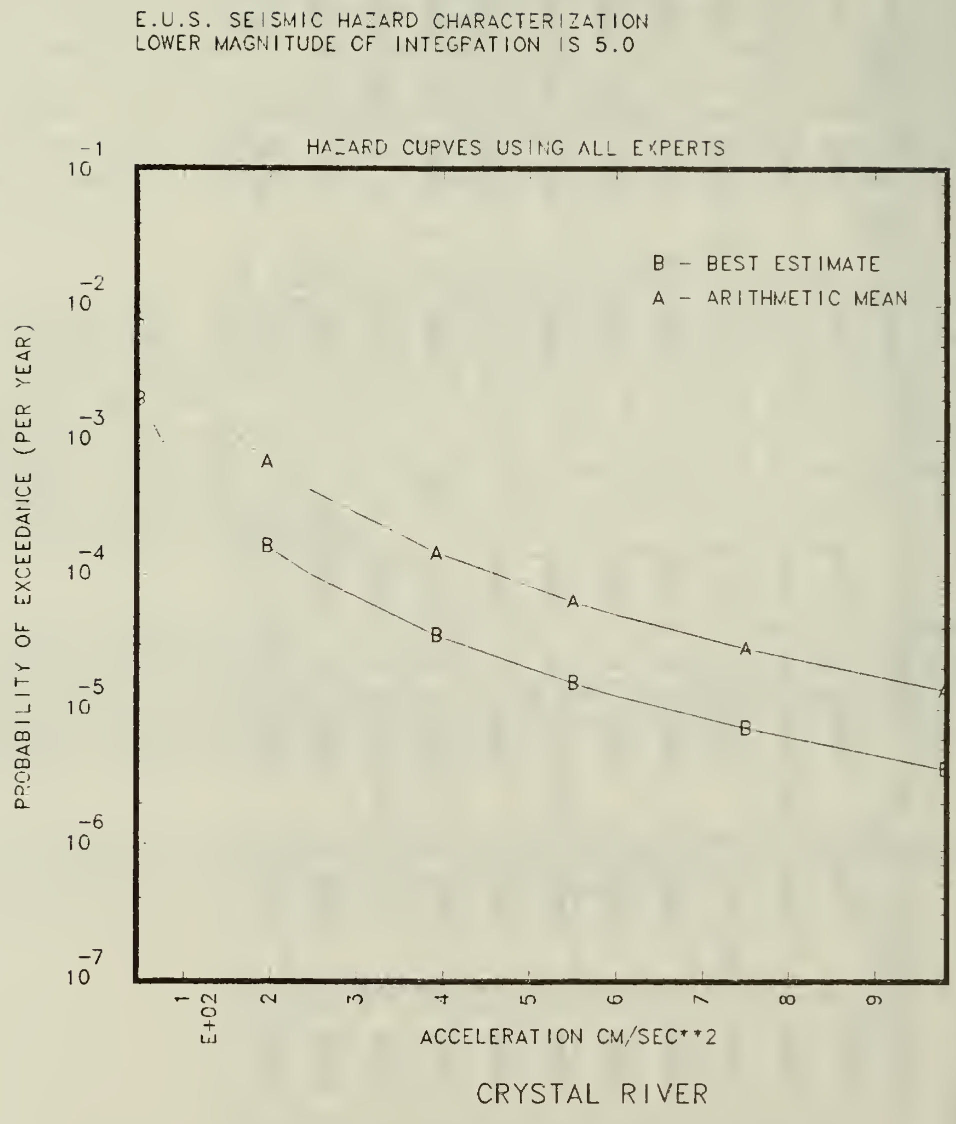

Figure 2.5.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Crystal River site.

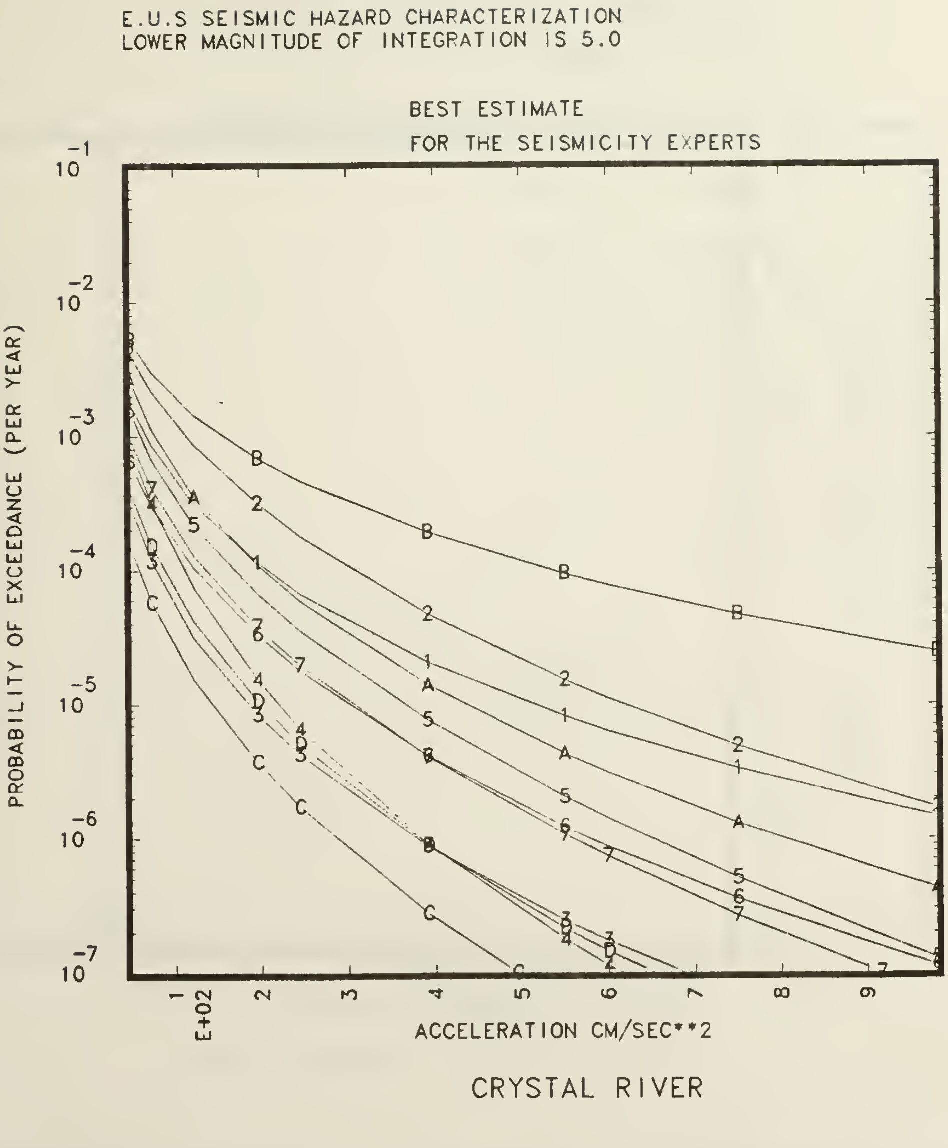

Figure 2.5.2 BEHCs per S-Expert combined over all G-Experts for the Crystal River site. Plot symbols given in Table 2.0.

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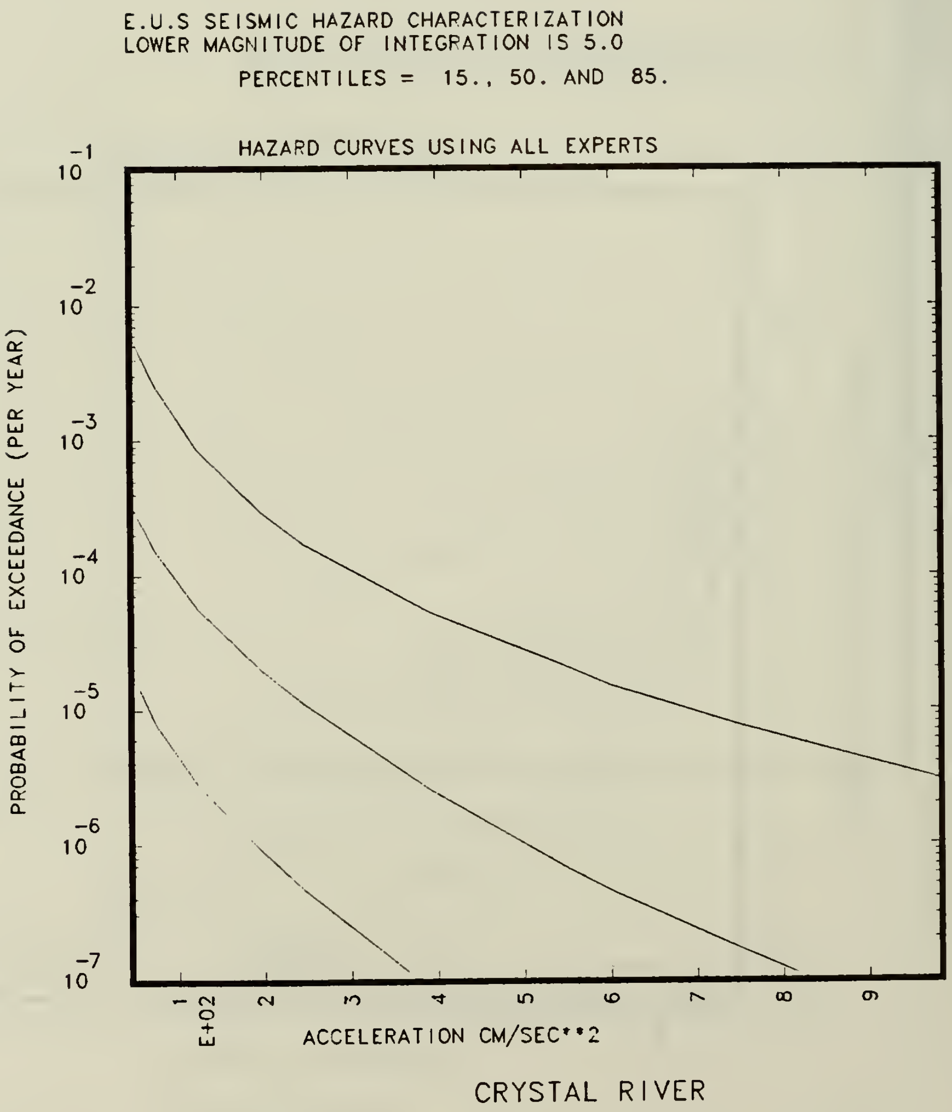

Figure 2.5.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Crystal River site.

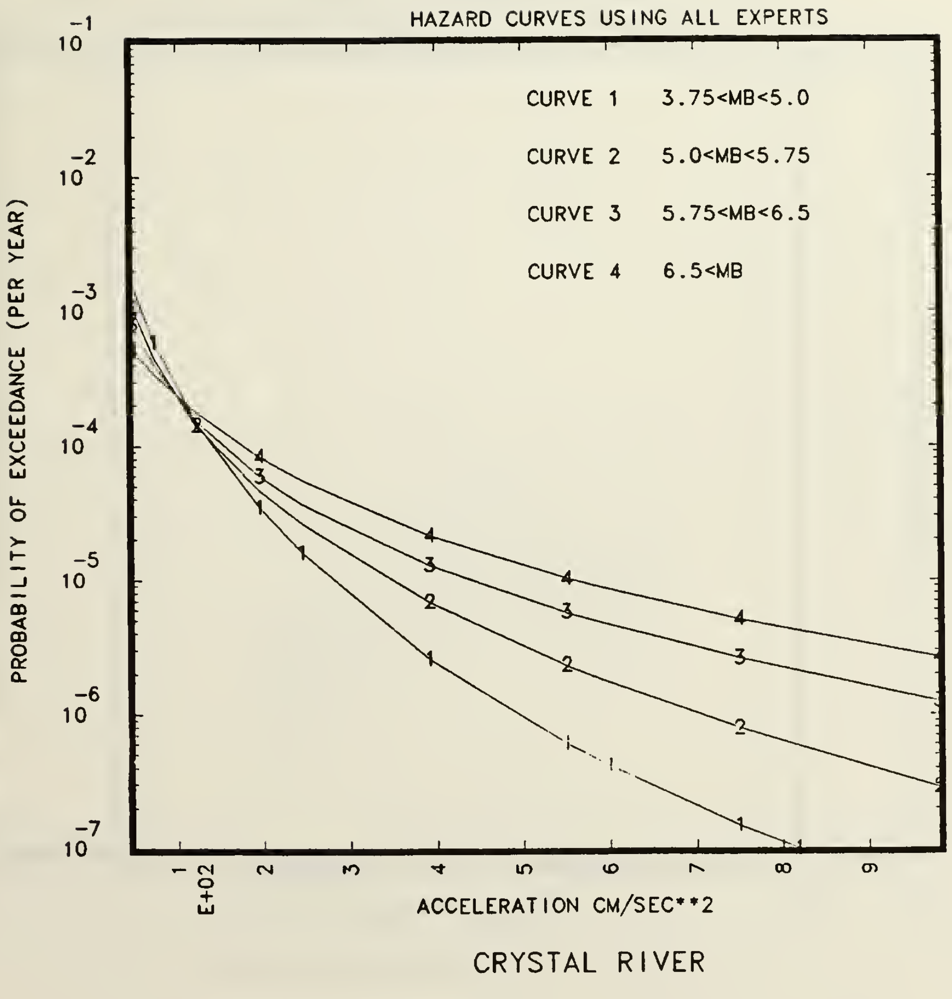

Figure 2.5.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Crystal River site.

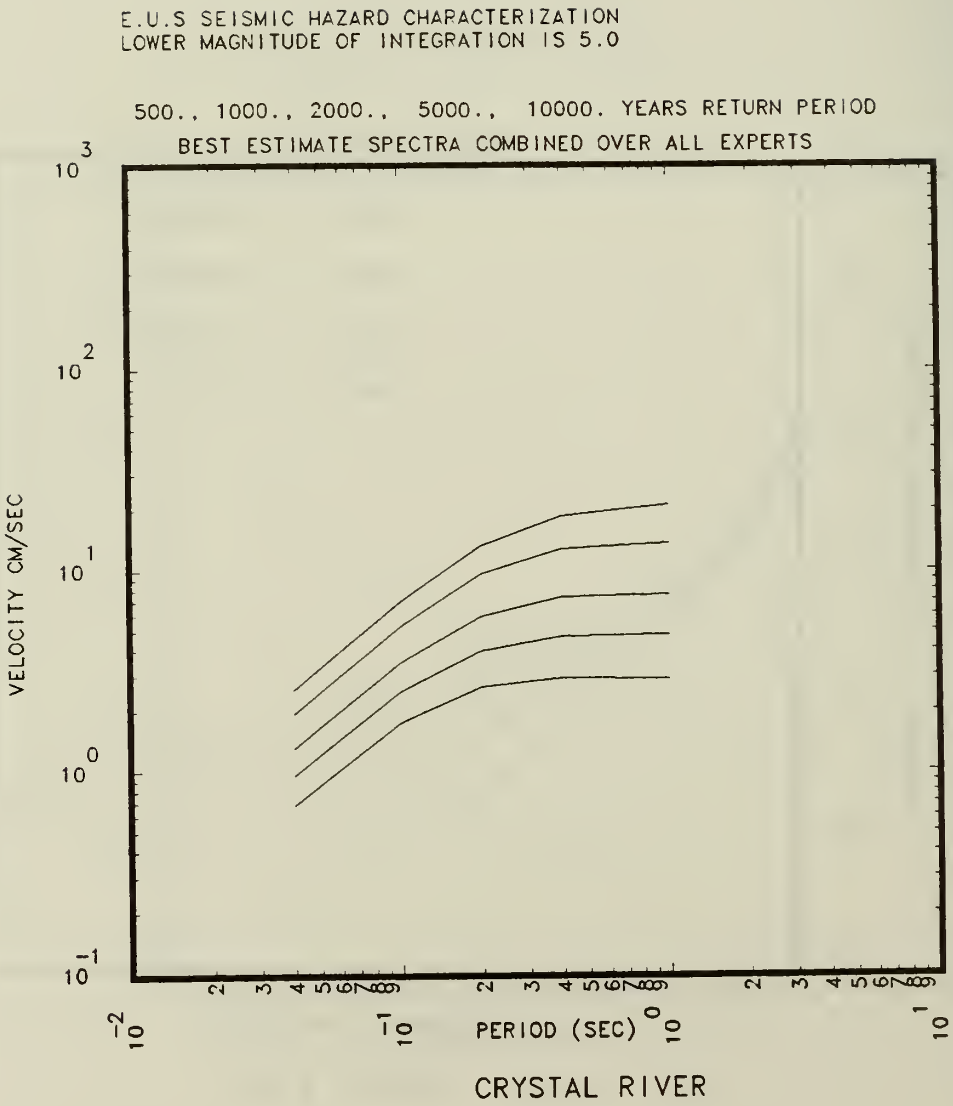

Figure 2.5.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Crystal River site.

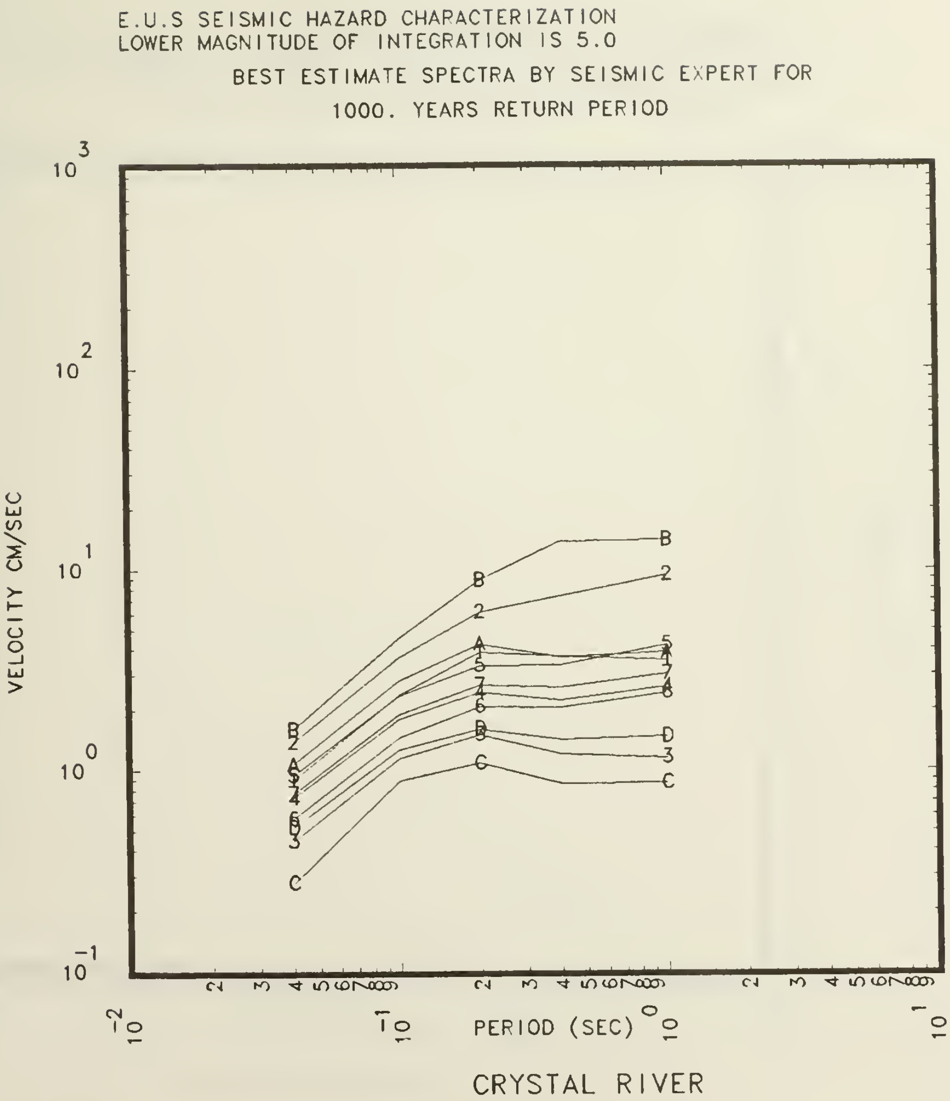

Figure 2.5.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Crystal River site. Plot symbols are given in Table 2.0.

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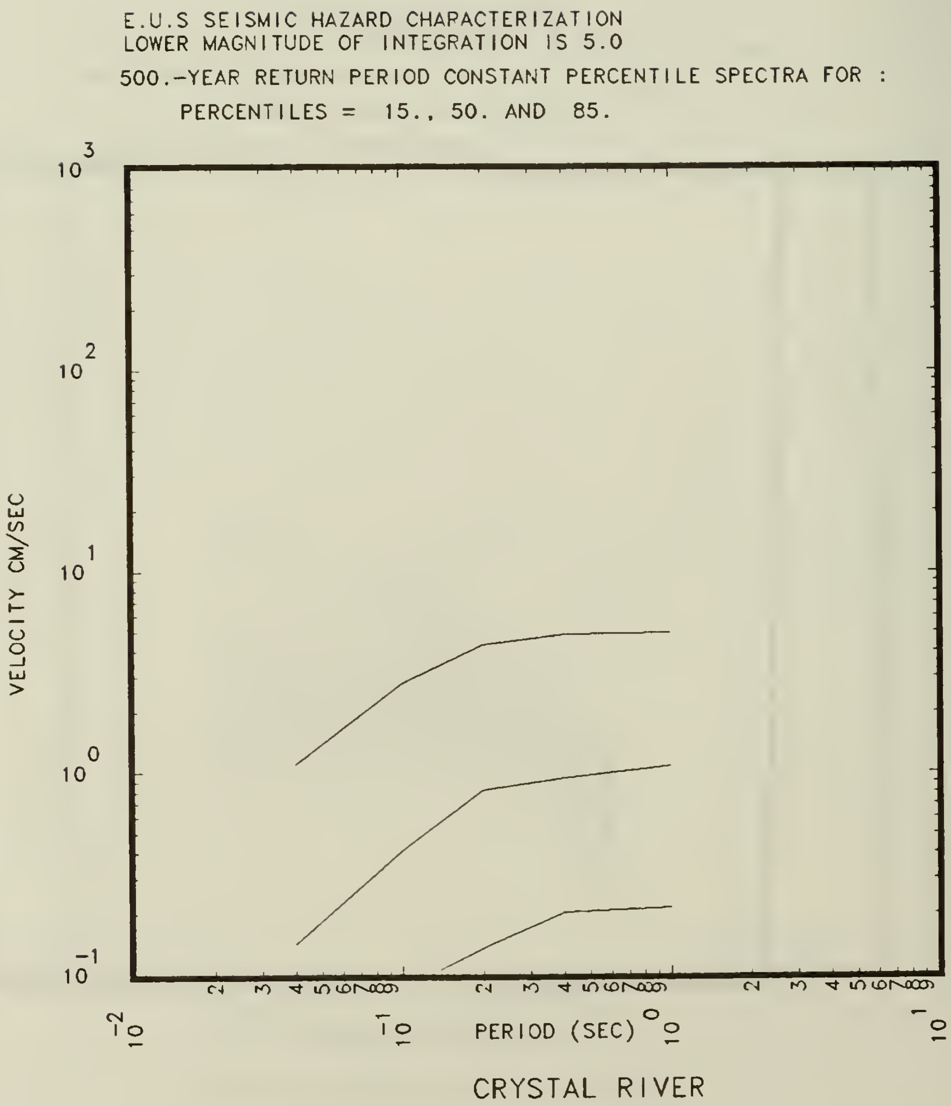

Figure 2.5.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Crystal River site.

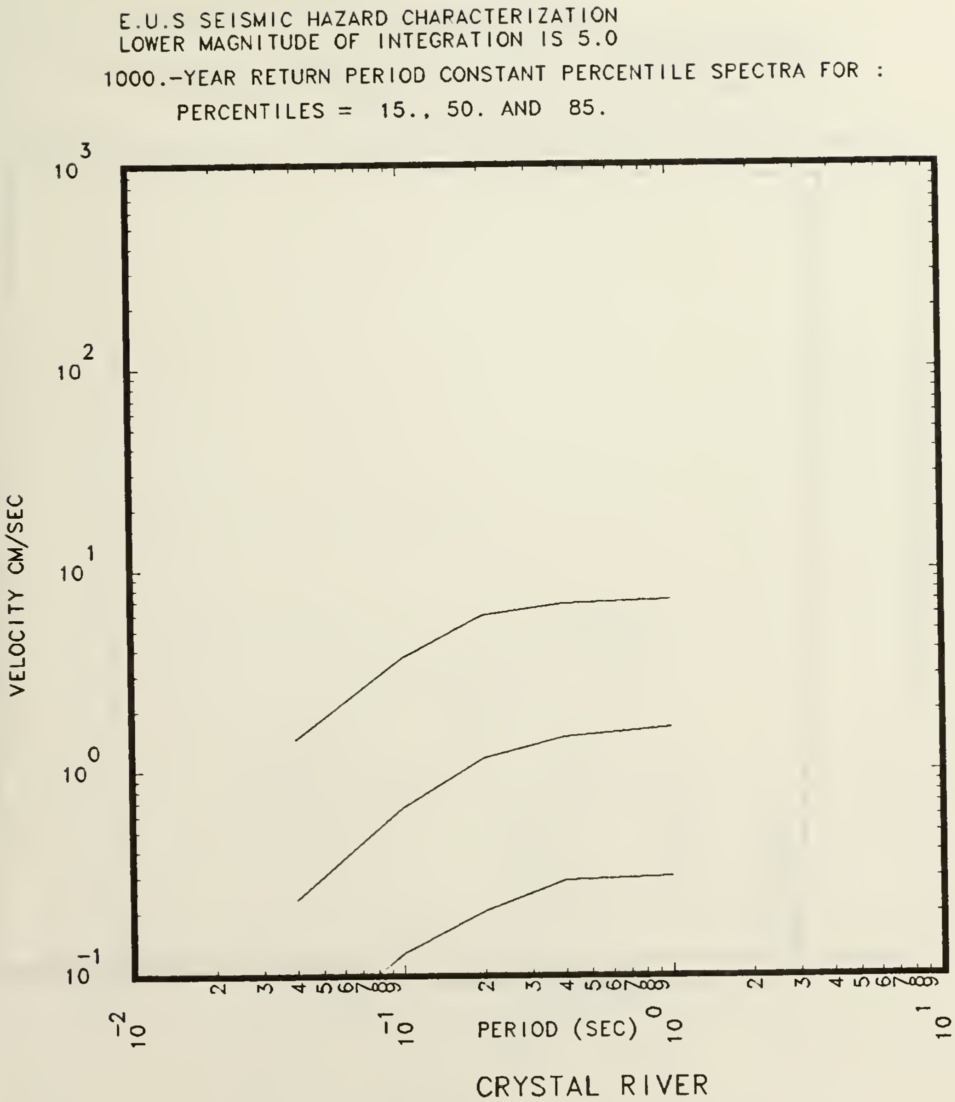

Figure 2.5.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Crystal River site.

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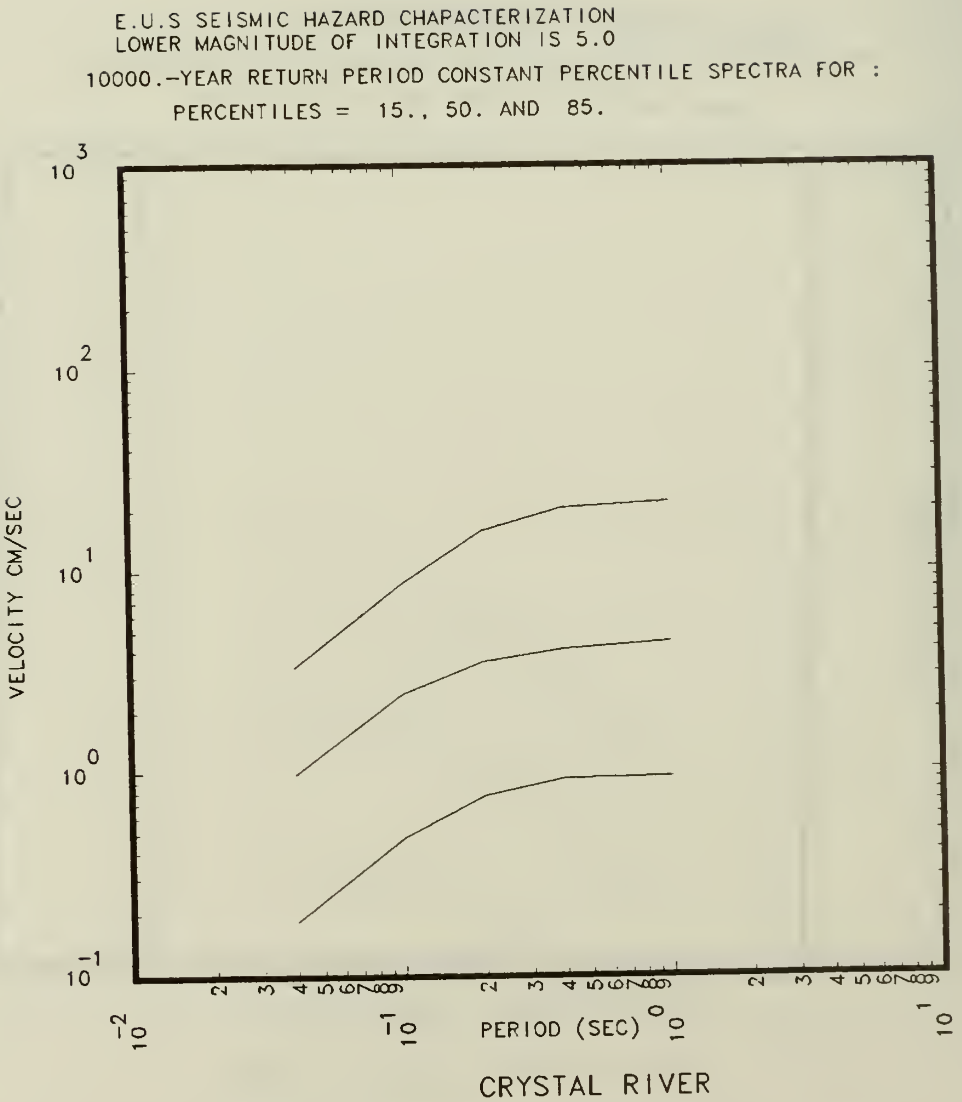

Figure 2.5.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Crystal River site.

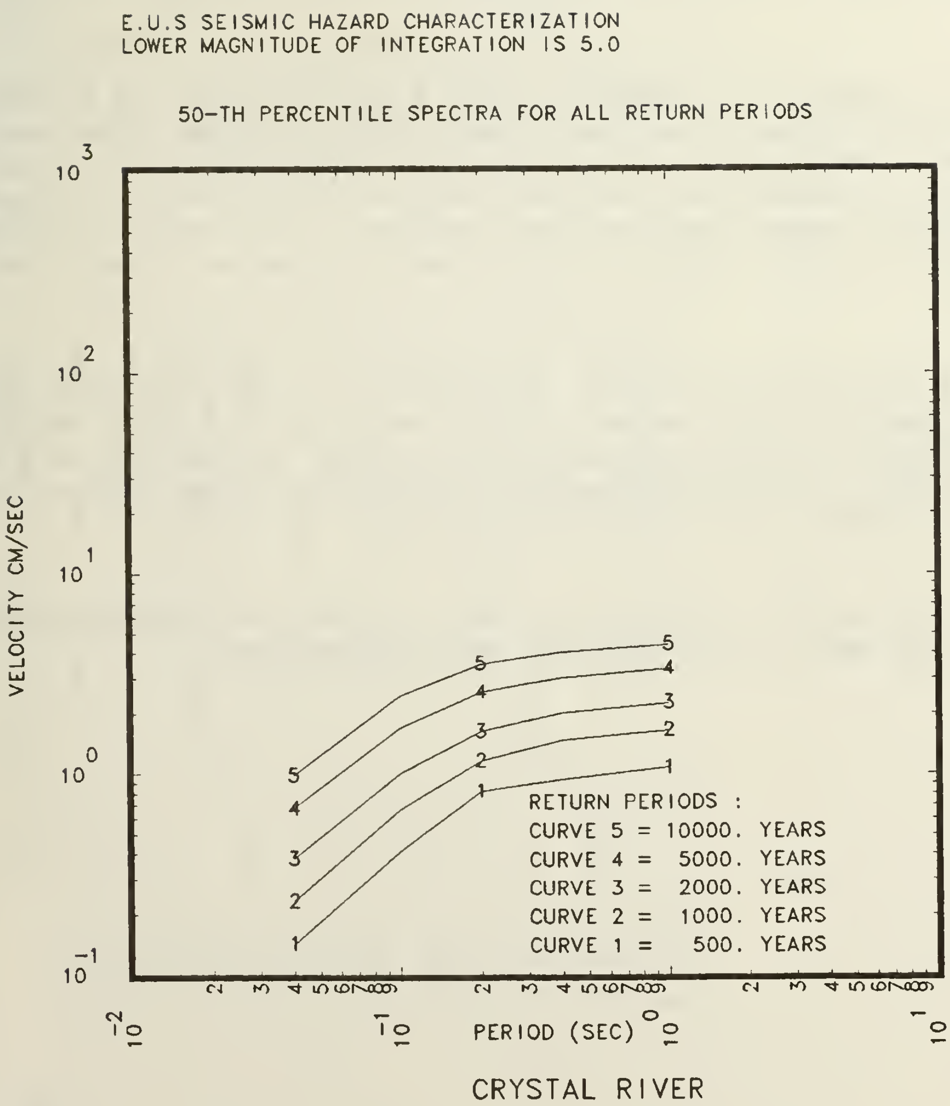

Figure 2.5.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Crystal River site.

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2.6 DUANE ARNOLD

Duane Arnold is a rock site and is represented by the symbol "6" in Fig. 1.1. Table 2.6.1 and Figs. 2.6.1 to 2.6.10 give the results of the analysis for this site. The AMHC is higher than the 85th percentile and the BEHC is between the 50th and the 85th percentile. This indicates the presence of some outlier curves in the simulation. Table 2.6.1 shows that for most S-Experts, the Duane Arnold site is located inside a complementary zone, with a relatively low upper magnitude cutoffs and low occurrence rates. Thus the dominant zones are distant zones which have high rates of occurrence and higher upper magnitude cutoffs such as the New Madrid zone. Indeed, the hazard comes for its most part from areas located 150 km or more from the site.

S-Expert 12 (symbol "C") appears to be an outlier in Fig. 2.6.2. This is because for this expert, the Duane Arnold site is located in the complementary zone (zone 4) which has a best estimate upper magnitude cutoff of 5.0 (see Table B12.1 in Appendix B), thus the first zones which contribute anything are already distant enough that the ground motion at the site be significantly attenuated, since the analysis only includes earthquakes of magnitude 5.0 and above.

Fig. 2.6.4 shows that the biggest contribution is from earthquakes greater than magnitude 6.5, with ranges 5.0 -5.75 and 5.75 - 6.5 contributing equally and earthquakes of magnitude between 3.75 and 5.0 contributing only very little. Hence including earthquakes in that latter range would not have changed the hazard significantly at this site.

The discussion given in Sections 2.1 and 2.3 relative to the dominance of G-Expert 5's GM model for the BEHC and AMHC also applies.

TABLE 2.6.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR DUANE ARNOLD

SITE SOIL CATEGORY ROCK

S-XPT NUM.	HOST ZONE		Low PGA (0.125G)				High PGA (0.60G)			
			ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 15	ZONE ID:	ZONE 9	ZONE 11	ZONE 10	ZONE 15	ZONE 9	ZONE 11	ZONE 10	ZONE 15
		% CONT.:	42.	29.	21.	5.	59.	27.	8.	4.
2	COMP. ZO	ZONE ID:	ZONE 18	COMP. ZON	ZONE 20	ZONE 21	ZONE 18	COMP. ZON	ZONE 21	ZONE 20
		% CONT.:	79.	11.	6.	2.	87.	13.	0.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 13	ZONE 12	ZONE 15	COMP. ZON	ZONE 13	ZONE 12	ZONE 15
		% CONT.:	33.	28.	27.	9.	80.	13.	5.	1.
4	ZONE 13	ZONE ID:	ZONE 4	ZONE 6	ZONE 5	ZONE 3	ZONE 4	ZONE 6	ZONE 13	ZONE 5
		% CONT.:	73.	15.	7.	3.	91.	6.	2.	1.
5	COMP. ZO	ZONE ID:	ZONE 15	ZONE 14	COMP. ZON	ZONE 12	ZONE 15	COMP. ZON	ZONE 14	ZONE 4
		% CONT.:	86.	7.	4.	2.	96.	4.	0.	0.
6	ZONE 22	ZONE ID:	ZONE 17	ZONE 22	ZONE 18	COMP. ZON	ZONE 22	ZONE 17	COMP. ZON	ZONE 18
		% CONT.:	45.	35.	10.	8.	70.	16.	9.	4.
7	ZONE 3	ZONE ID:	ZONE 6	ZONE 3	ZONE 5	ZONE 2 =	ZONE 6	ZONE 3	ZONE 2 =	ZONE 5
		% CONT.:	91.	5.	4.	1.	92.	8.	0.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 12A	ZONE 32	ZONE 13	ZONE 19 =	ZONE 12A	ZONE 32	ZONE 26A
		% CONT.:	80.	12.	3.	3.	99.	1.	0.	0.
11	CZ = ZON	ZONE ID:	CZ = ZONE	ZONE 10	ZONE 11	ZONE 15	CZ = ZONE	ZONE 10	ZONE 11	ZONE 6
		% CONT.:	61.	29.	9.	1.	93.	6.	1.	0.
12	ZONE 4 =	ZONE ID:	ZONE 15	ZONE 13	ZONE 14	ZONE 7	ZONE 15	ZONE 14	ZONE 13	ZONE 5
		% CONT.:	49.	27.	18.	6.	98.	1.	0.	0.
13	CZ 15	ZONE ID:	CZ 15	ZONE 5	ZONE 6	ZONE 4	CZ 15	ZONE 5	ZONE 1	ZONE 3
		% CONT.:	61.	34.	3.	1.	88.	12.	0.	0.

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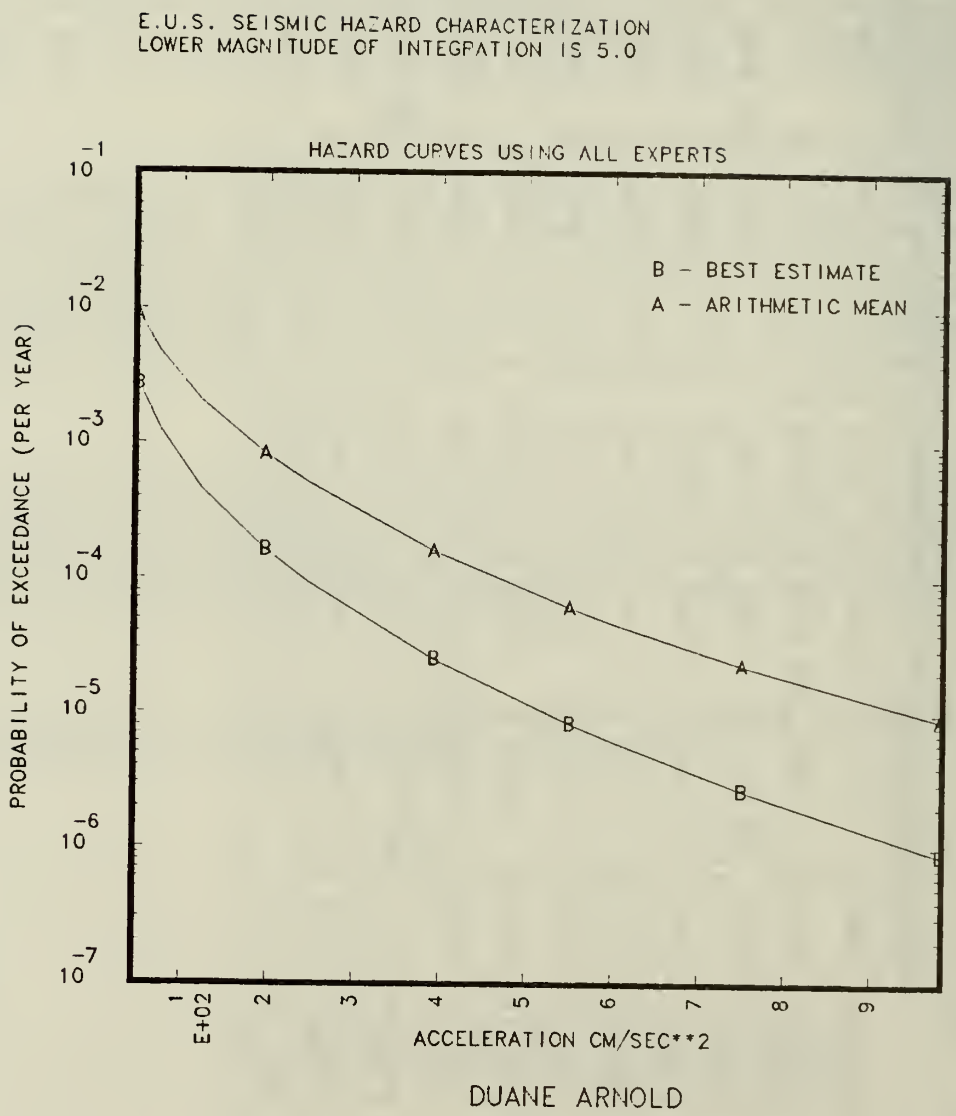

Figure 2.6.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Duane Arnold site.

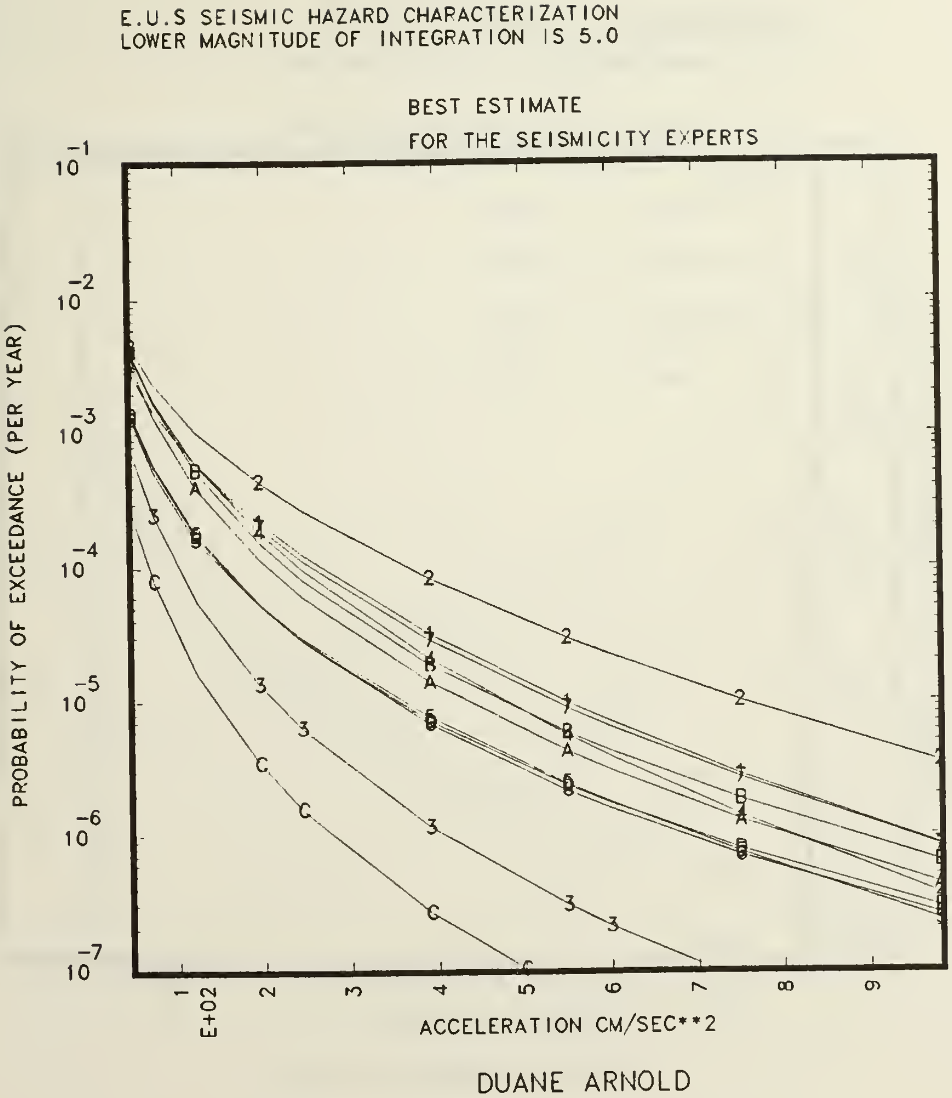

Figure 2.6.2 BEHCs per S-Expert combined over all G-Experts for the Duane Arnold site. Plot symbols given in Table 2.0.

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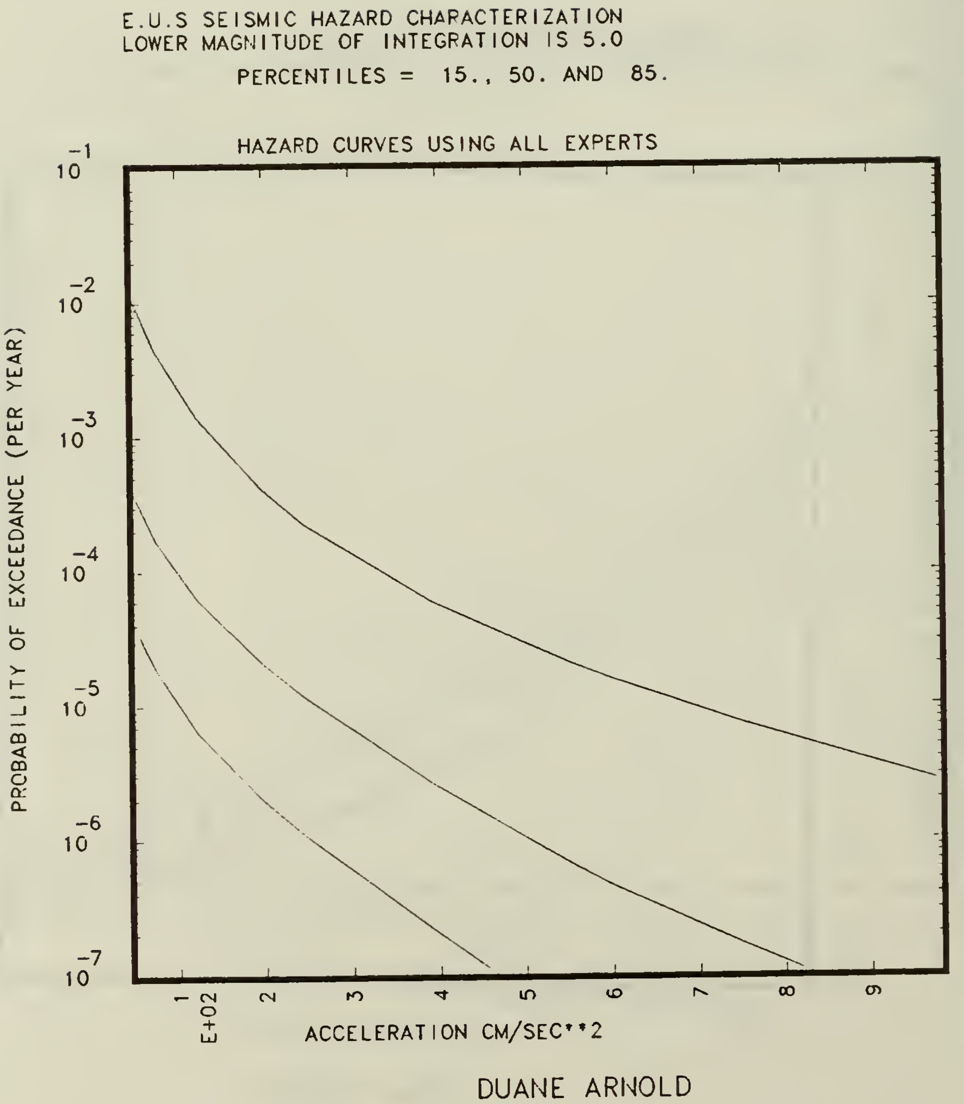

Figure 2.6.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Duane Arnold site.

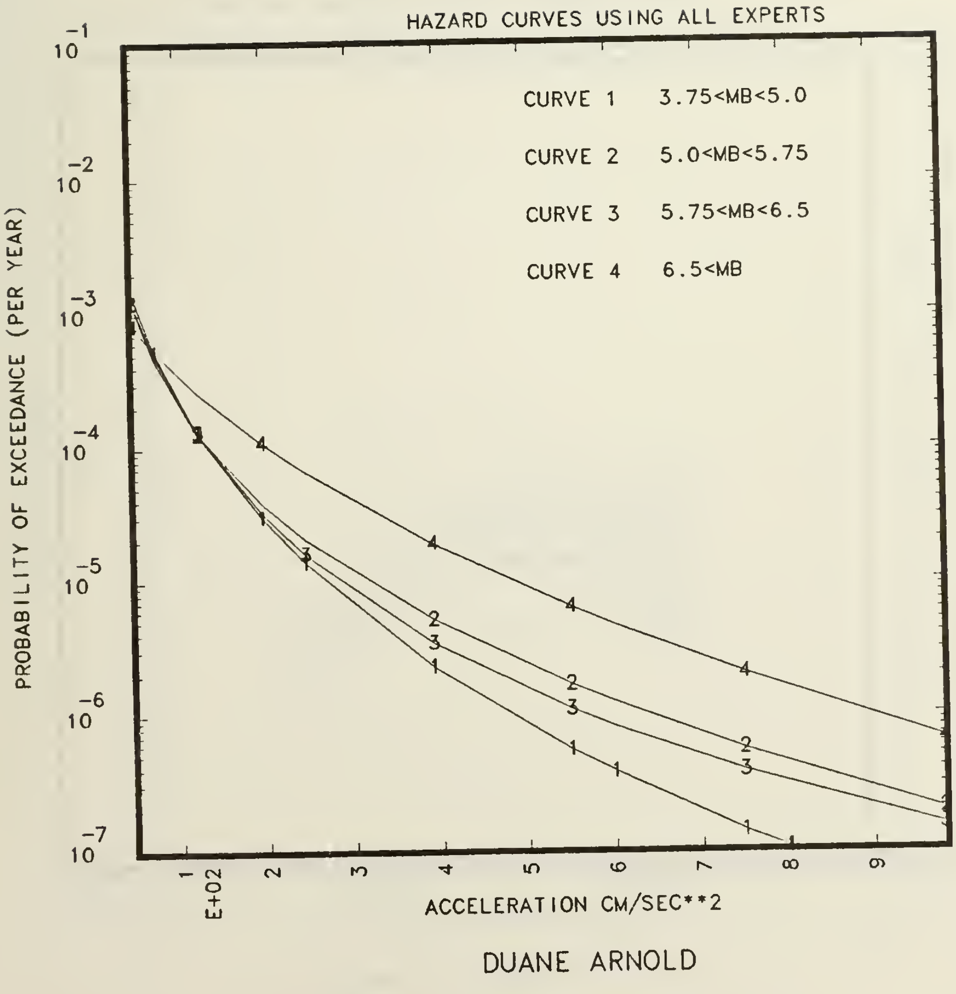

Figure 2.6.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Duane Arnold site.

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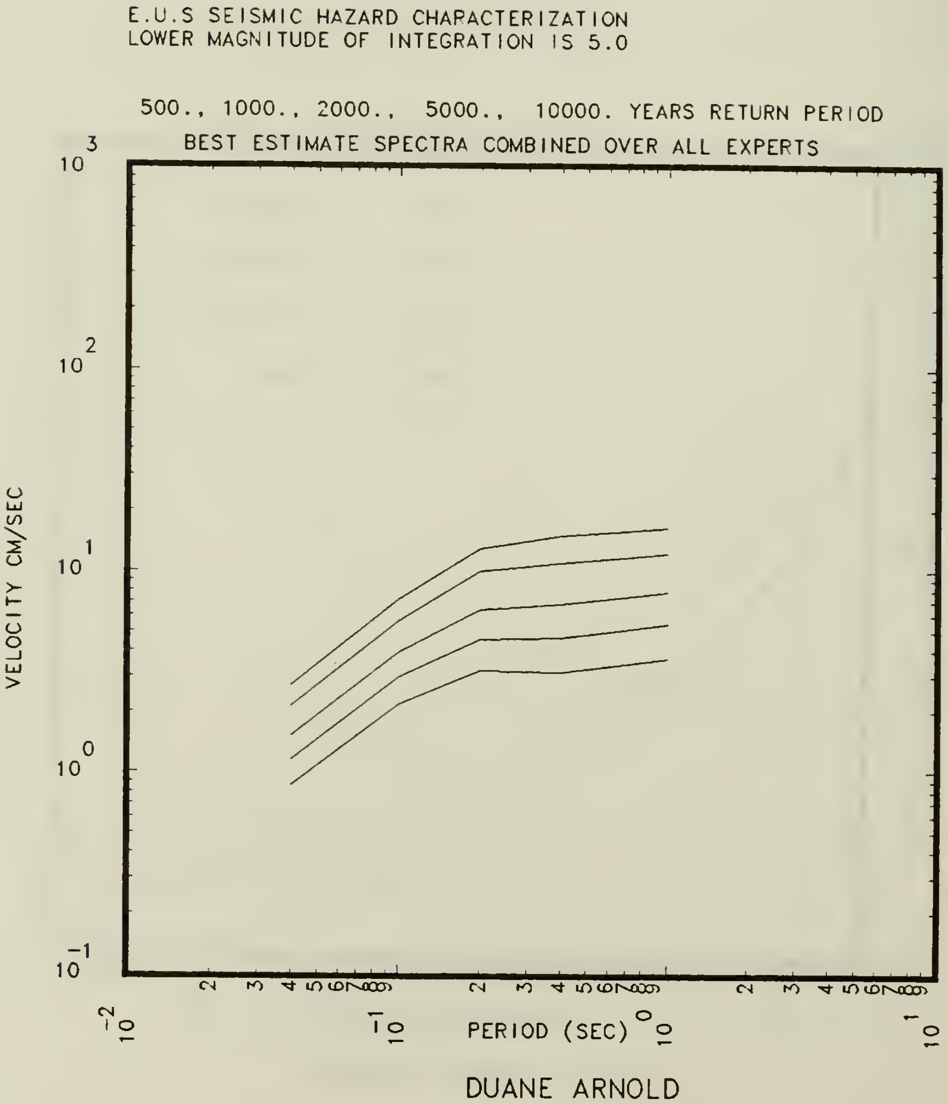

Figure 2.6.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Duane Arnold site.

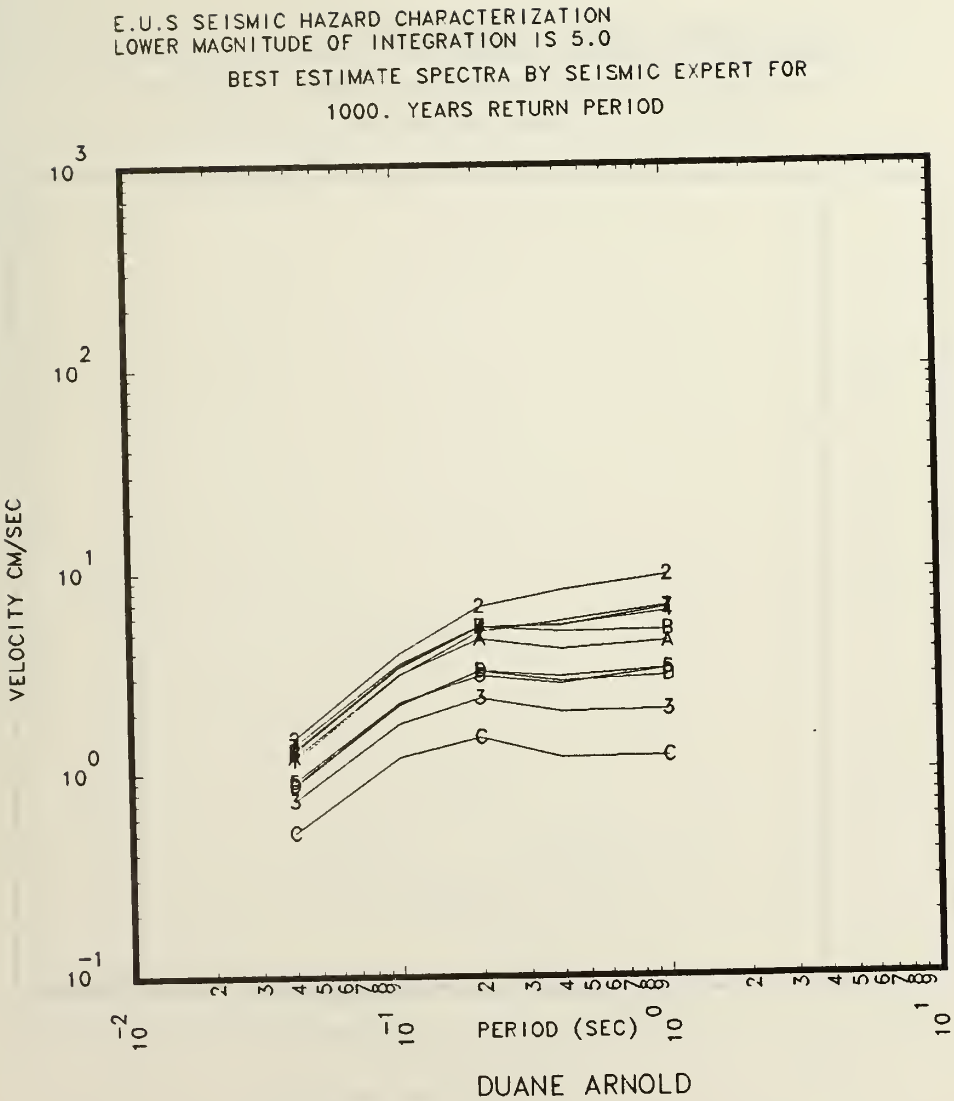

Figure 2.6.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Duane Arnold site. Plot symbols are given in Table 2.0.

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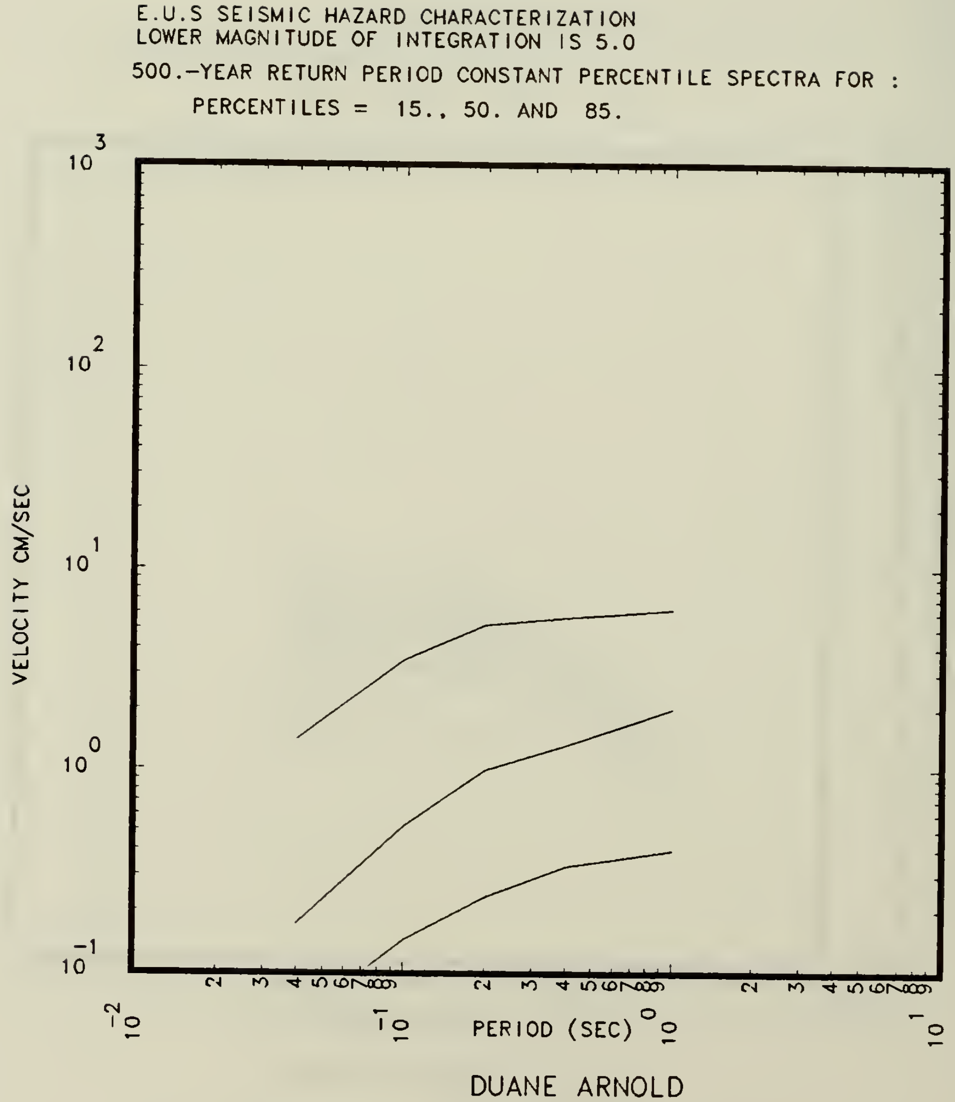

Figure 2.6.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Duane Arnold site.

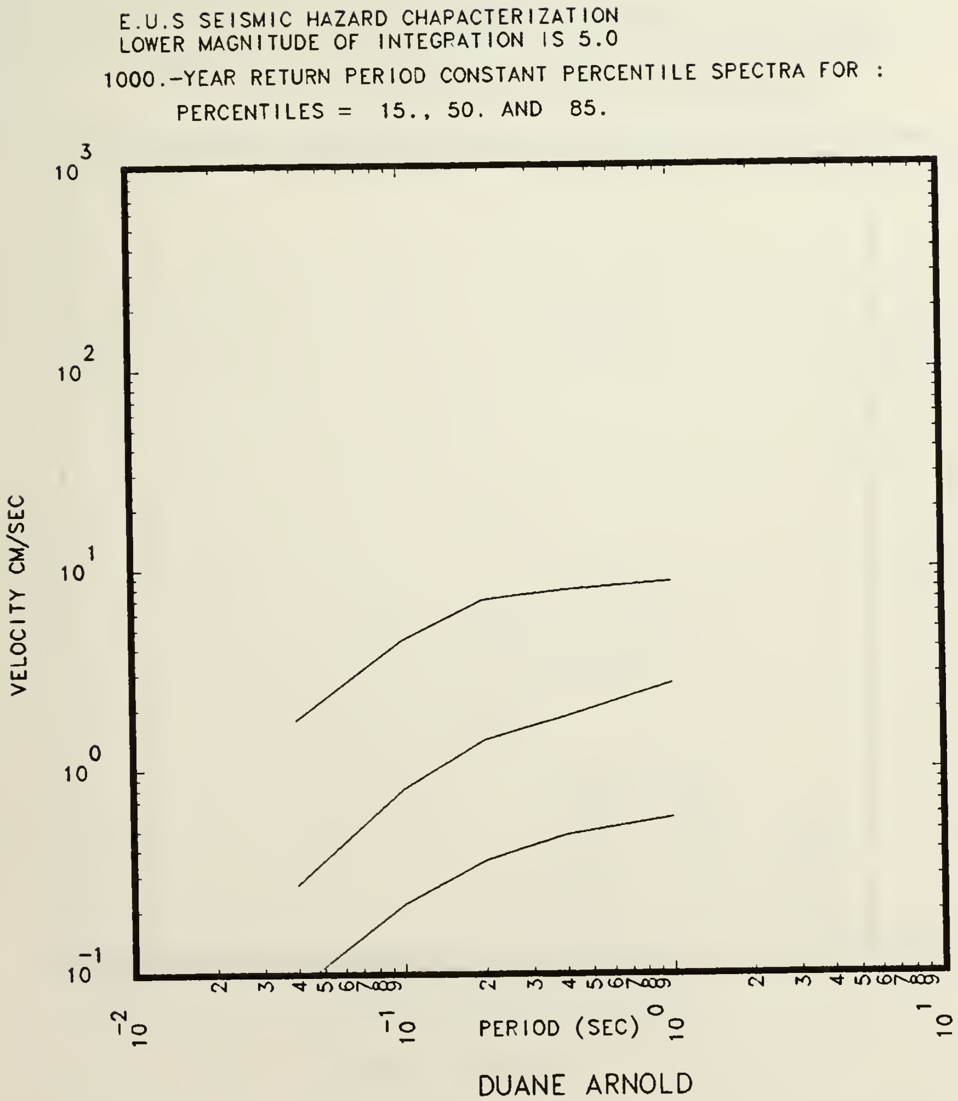

Figure 2.6.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Duane Arnold site.

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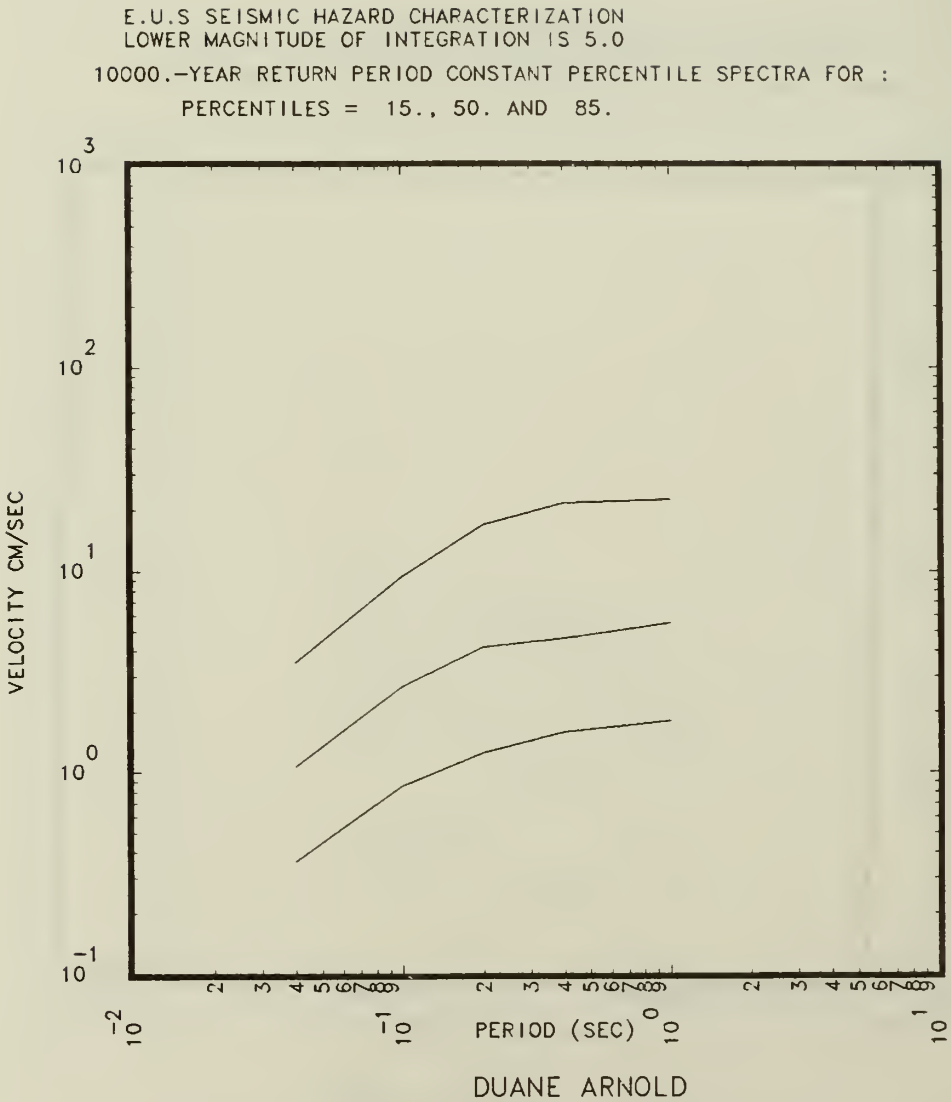

Figure 2.6.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Duane Arnold site.

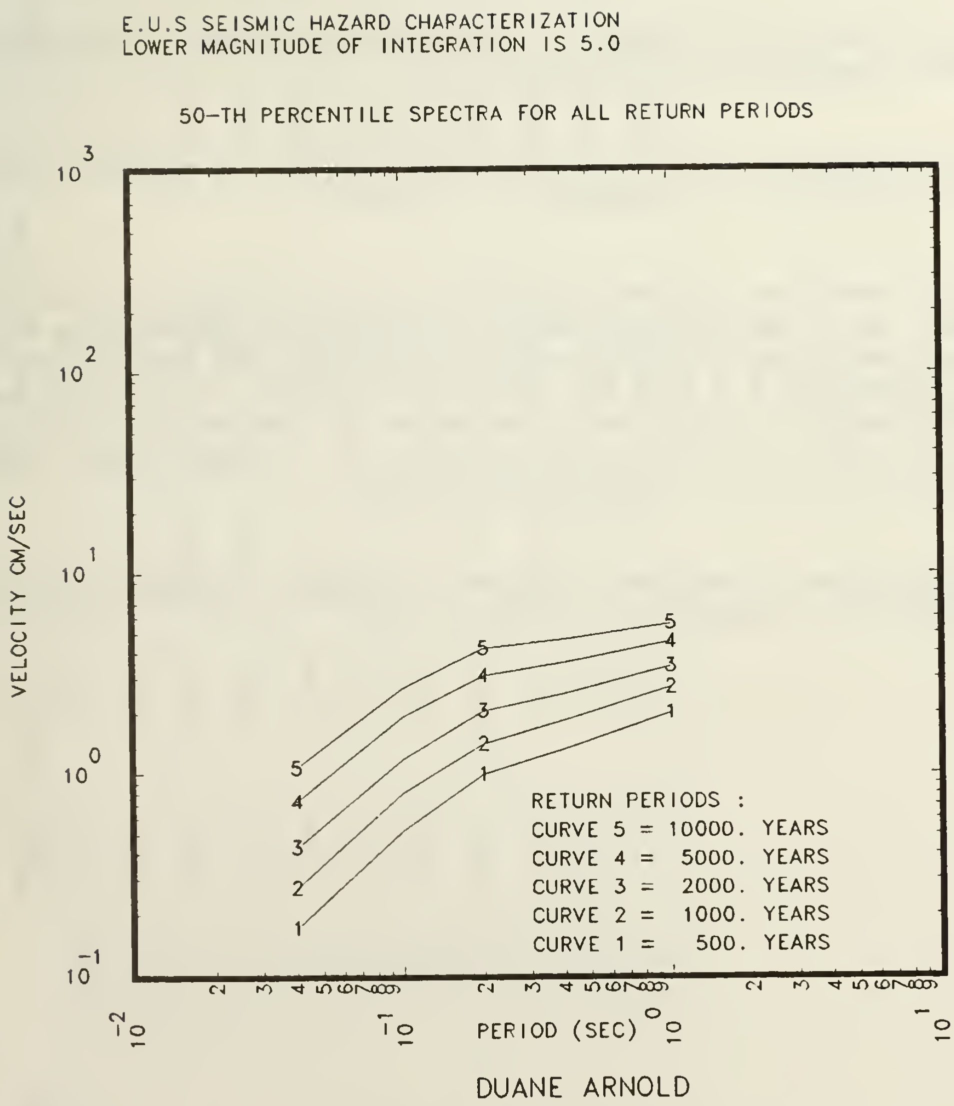

Figure 2.6.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Duane Arnold site.

2.7 FORT CALHOUN

Fort Calhoun was placed in the sand-1 (see table 1.4) category. It is located in region 3 (North Central) and is represented by the symbol "7" on the location map (Fig. 1.1). Table 2.7.1 and Figs. 2.7.1 to 2.7.10 give the results of the analysis for this site. We see from Table 2.7.1 and the maps in Appendix A that this site is located within a relatively short distance of the zones representing the Omaha-Nemaha ridge zone as modeled by 7 of the S-Experts. The New Madrid zone also plays an important role for most experts, particularly at low PGA values, where it dominates the hazard for a number of S-Experts.

Figure 2.7.1 shows typical results. In addition, the AMHC is slightly higher than the 85th percentile, (see Fig. 2.7.3).

Figure 2.7.2 indicates that the diversity of opinion, as measured by the spread of the BEHC for all S-Experts, is typical.

Figure 2.7.4 shows the relative contribution of earthquakes in several ranges of magnitude. Up to approximately 0.2g, the hazard is dominated by earthquakes in the lowest magnitude bin, but beyond this values, the earthquakes in the second bin (magnitude 5.0 to 5.75) contribute the most to the total hazard. Thus the BEHC would be significantly increased in the range 0.05g to 0.5g if earthquakes in the 3.75 to 5. magnitude range were included; approximately a factor of 3 at 0.05g and a factor of 2 at 0.2g.

The discussion given in Section 2.4 about the relative spread between the G-Experts' BEHCs per S-Expert holds for this site.

TABLE 2.7.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR FORT CALHOUN

SITE SOIL CATEGORY SAND-1

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 15	ZONE ID:	ZONE 9	ZONE 15	ZONE 10	ZONE 14	ZONE 15	ZONE 9	ZONE 10	ZONE 14
		% CONT.:	41.	22.	16.	12.	70.	27.	3.	1.
2	COMP. ZO	ZONE ID:	ZONE 18	COMP. ZON	ZONE 13	ZONE 15	COMP. ZON	ZONE 18	ZONE 13	ZONE 15
		% CONT.:	63.	28.	4.	4.	73.	27.	0.	0.
3	ZONE 16	ZONE ID:	ZONE 16	COMP. ZON	ZONE 13	ZONE 12	ZONE 16	COMP. ZON	ZONE 13	ZONE 11
		% CONT.:	95.	3.	1.	1.	99.	1.	0.	0.
4	COMP. ZO	ZONE ID:	ZONE 4	ZONE 1	COMP. ZON	ZONE 13	ZONE 4	COMP. ZON	ZONE 13	ZONE 1
		% CONT.:	70.	22.	3.	3.	56.	32.	6.	6.
5	COMP. ZO	ZONE ID:	ZONE 15	COMP. ZON	ZONE 17	ZONE 14	ZONE 15	COMP. ZON	ZONE 13	ZONE 14
		% CONT.:	78.	19.	2.	1.	52.	48.	0.	0.
6	COMP. ZO	ZONE ID:	ZONE 31	COMP. ZON	ZONE 17	ZONE 27	COMP. ZON	ZONE 31	ZONE 27	ZONE 17
		% CONT.:	54.	26.	10.	5.	73.	26.	1.	0.
7	ZONE 31	ZONE ID:	ZONE 6	ZONE 31	ZONE 2 =	ZONE 33	ZONE 31	ZONE 6	ZONE 2 =	ZONE 33
		% CONT.:	49.	42.	5.	3.	84.	15.	1.	0.
10	ZONE 32	ZONE ID:	ZONE 32	ZONE 19 =	ZONE 12A	ZONE 13	ZONE 32	ZONE 19 =	ZONE 12A	ZONE 13
		% CONT.:	80.	20.	0.	0.	92.	8.	0.	0.
11	ZONE 17	ZONE ID:	ZONE 17	CZ = ZONE	ZONE 11	ZONE 10	ZONE 17	CZ = ZONE	ZONE 10	ZONE 11
		% CONT.:	77.	20.	1.	1.	94.	6.	0.	0.
12	ZONE 4 =	ZONE ID:	ZONE 7	ZONE 15	ZONE 3	ZONE 6	ZONE 7	ZONE 15	ZONE 3	ZONE 6
		% CONT.:	94.	2.	2.	1.	89.	10.	1.	0.
13	ZONE 18	ZONE ID:	ZONE 18	CZ 15	ZONE 5	ZONE 1	ZONE 18	CZ 15	ZONE 5	ZONE 1
		% CONT.:	86.	12.	1.	0.	96.	4.	0.	0.

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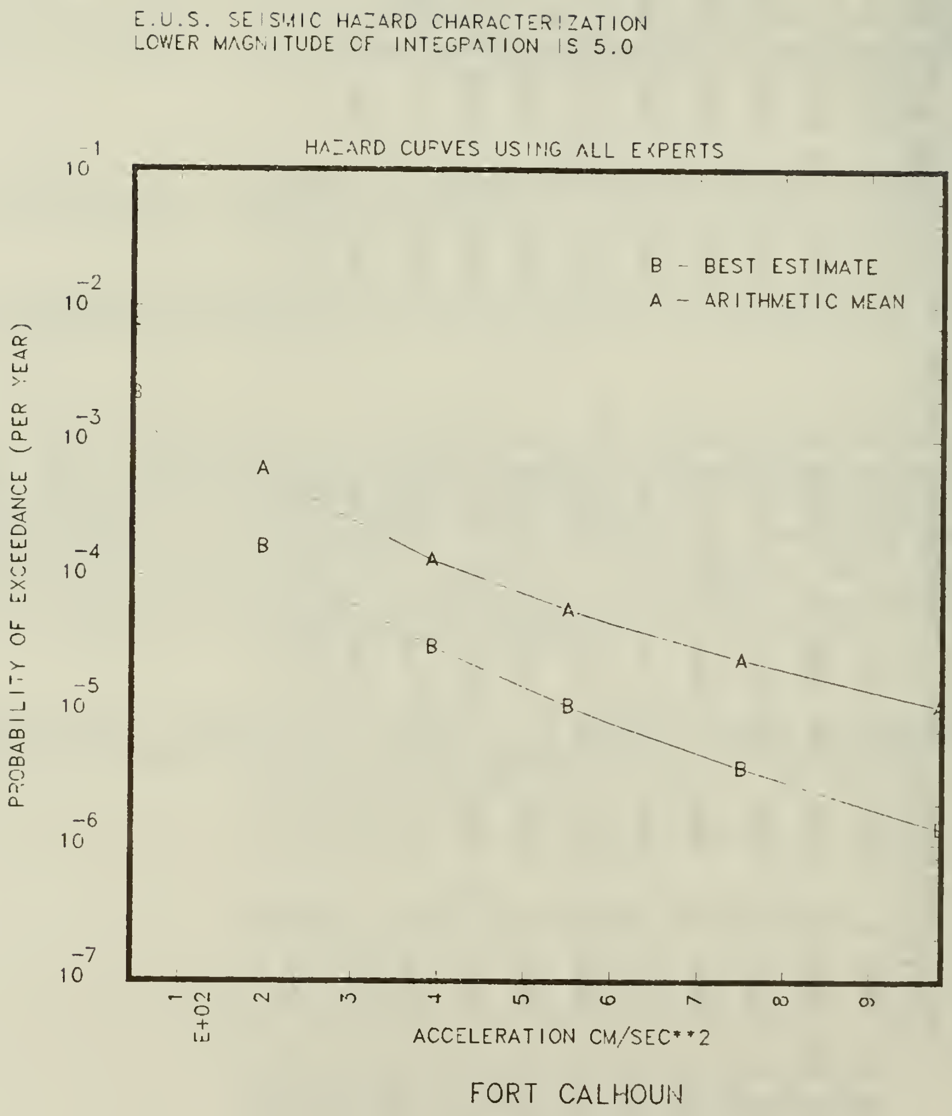

Figure 2.7.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Fort Calhoun site.

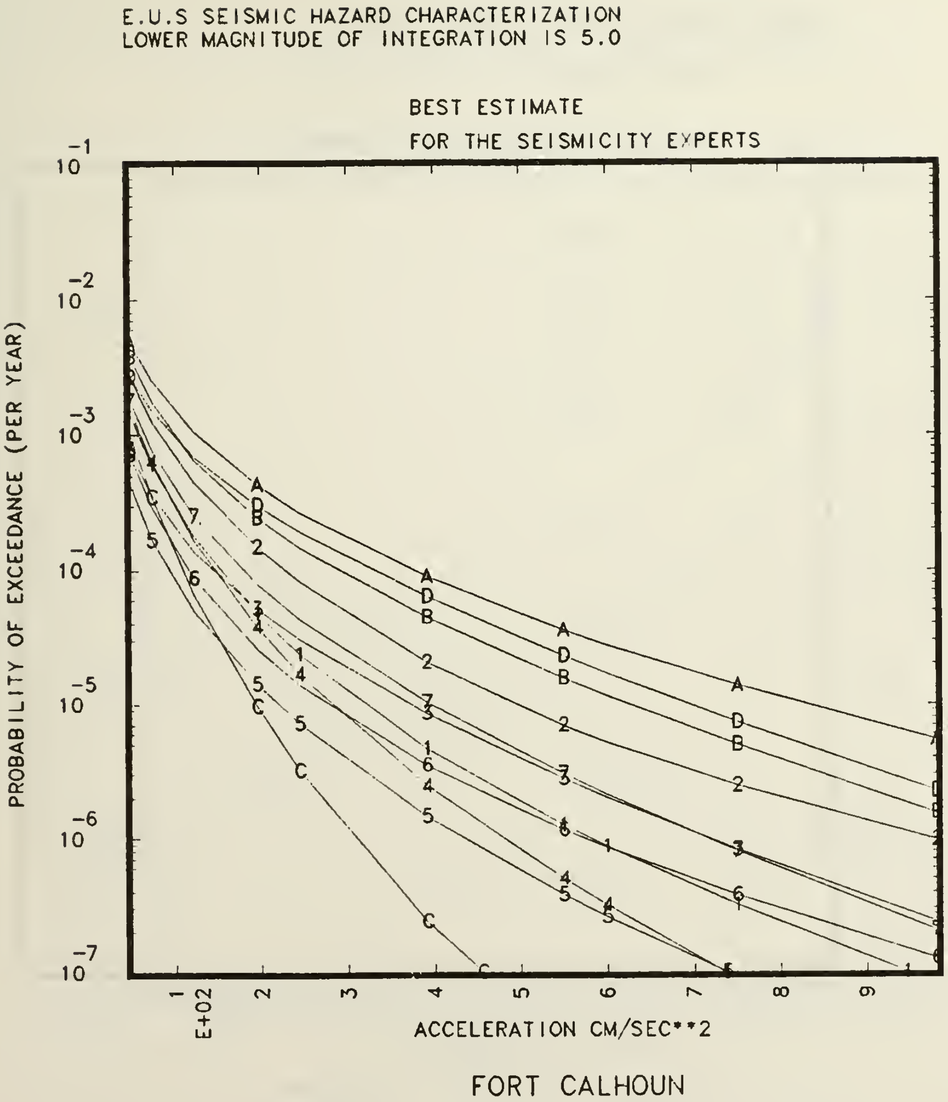

Figure 2.7.2 BEHCs per S-Expert combined over all G-Experts for the Fort Calhoun site. Plot symbols given in Table 2.0.

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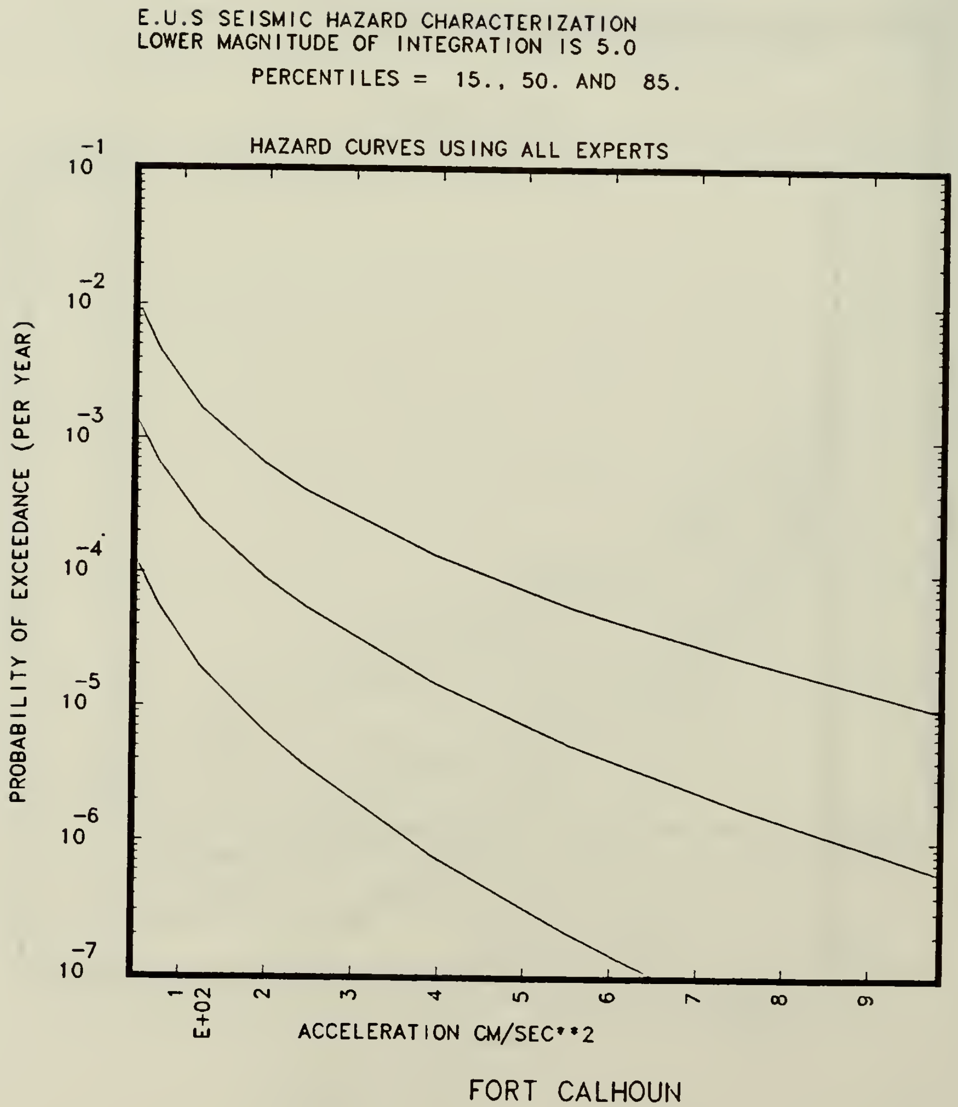
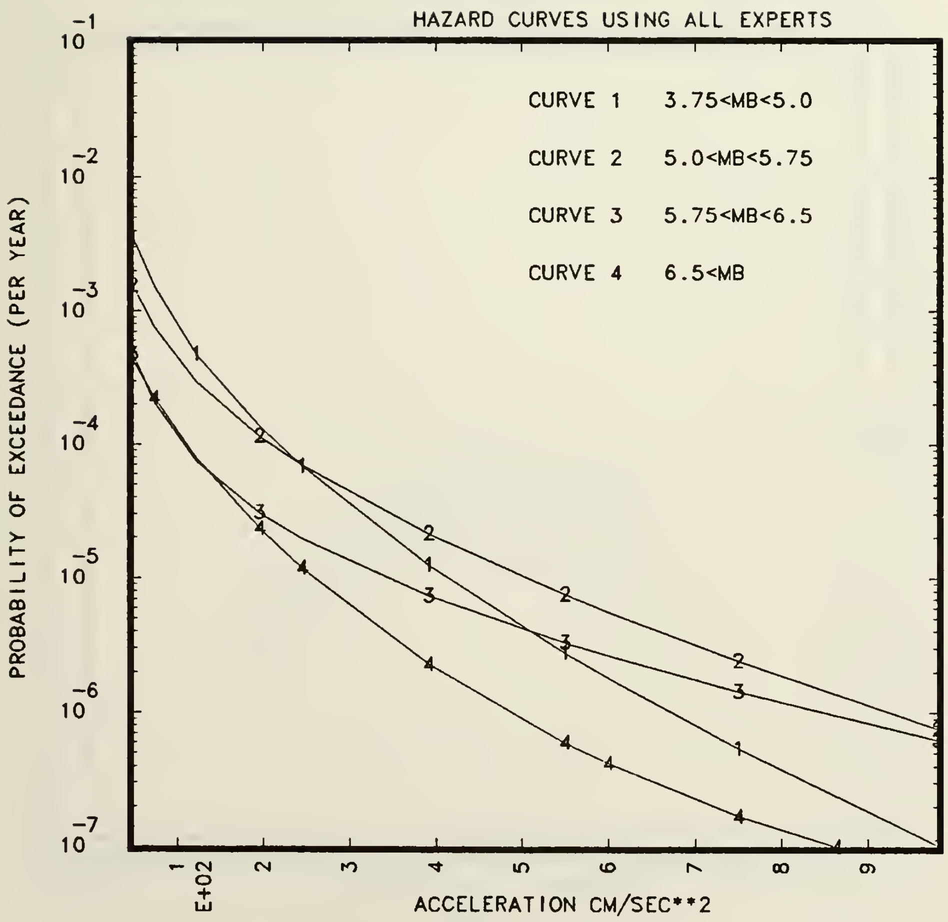


Figure 2.7.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Fort Calhoun site.



FORT CALHOUN

Figure 2.7.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Fort Calhoun site.

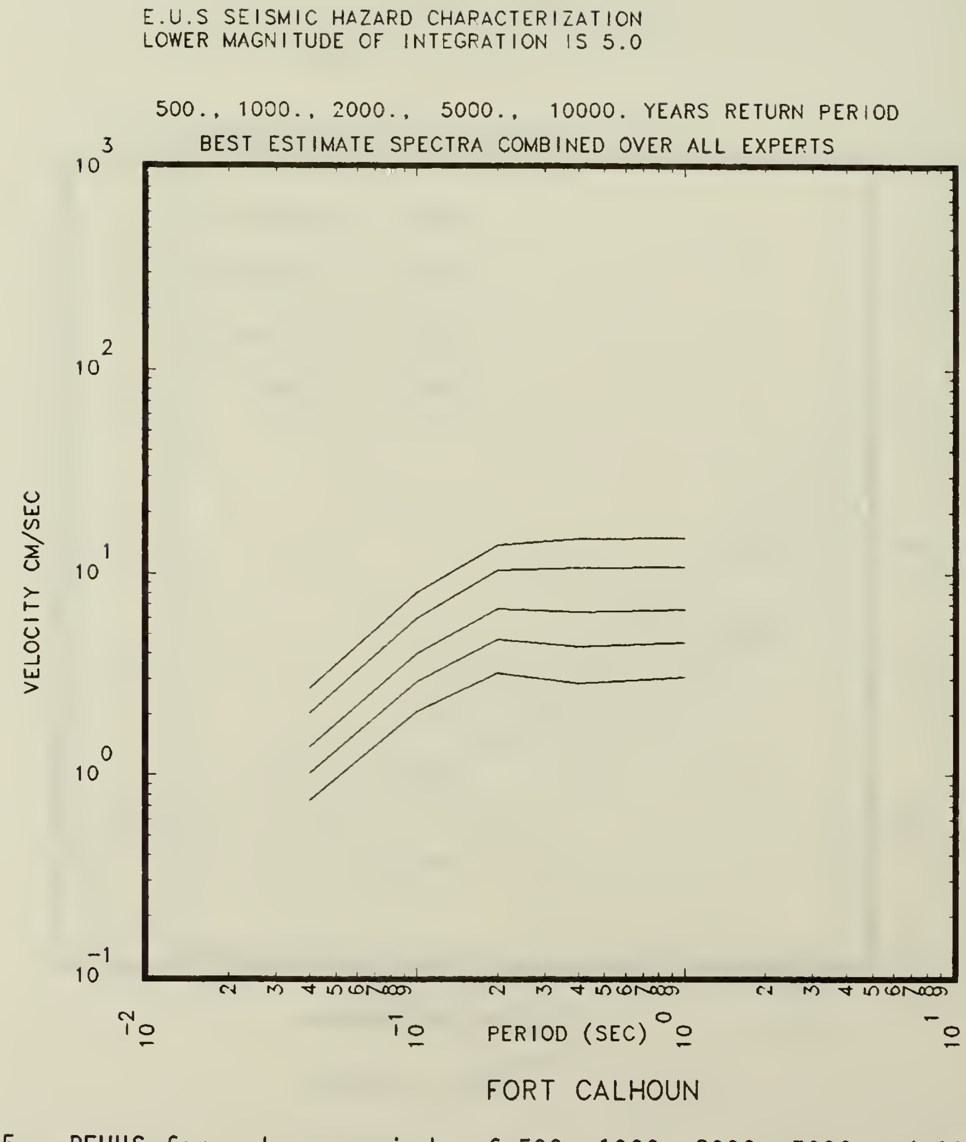
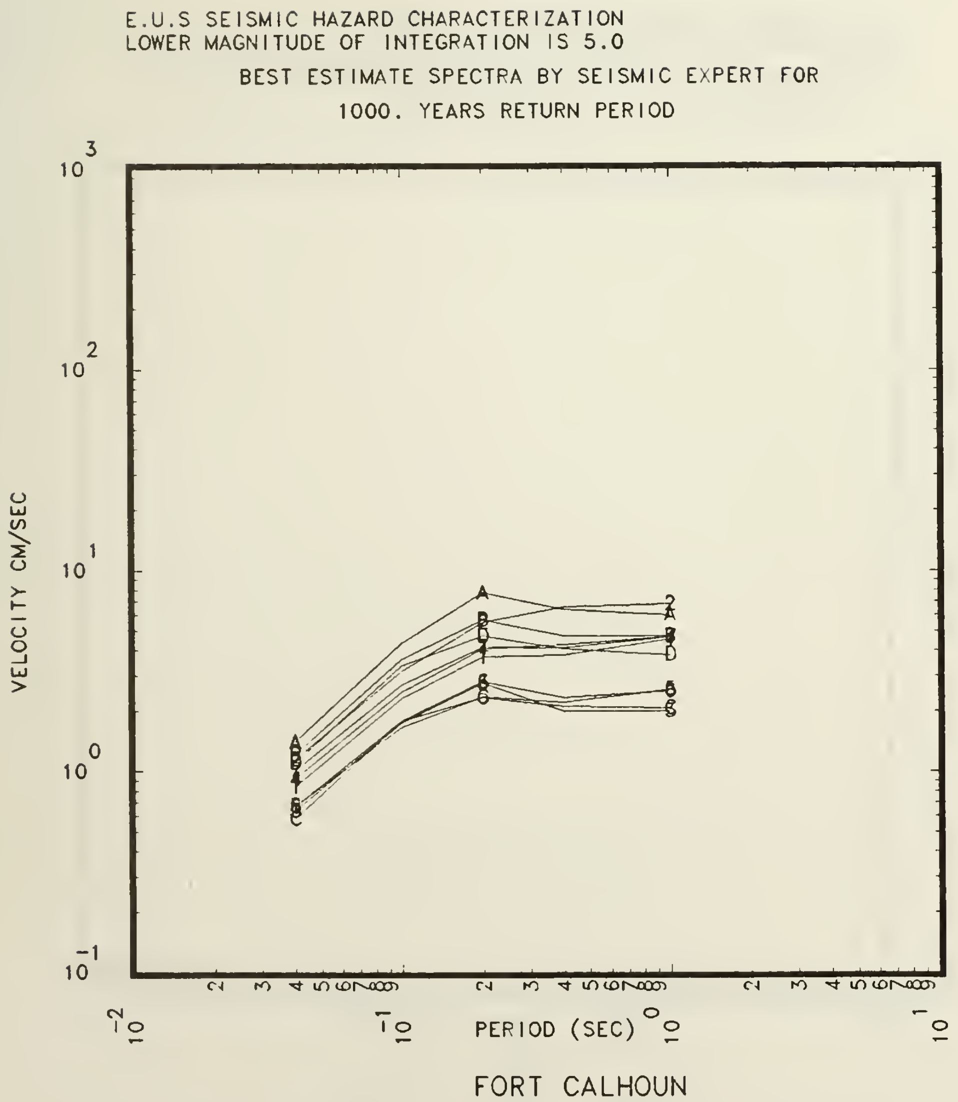


Figure 2.7.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Fort Calhoun site.



igure 2.7.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Fort Calhoun site. Plot symbols are given in Table 2.0.

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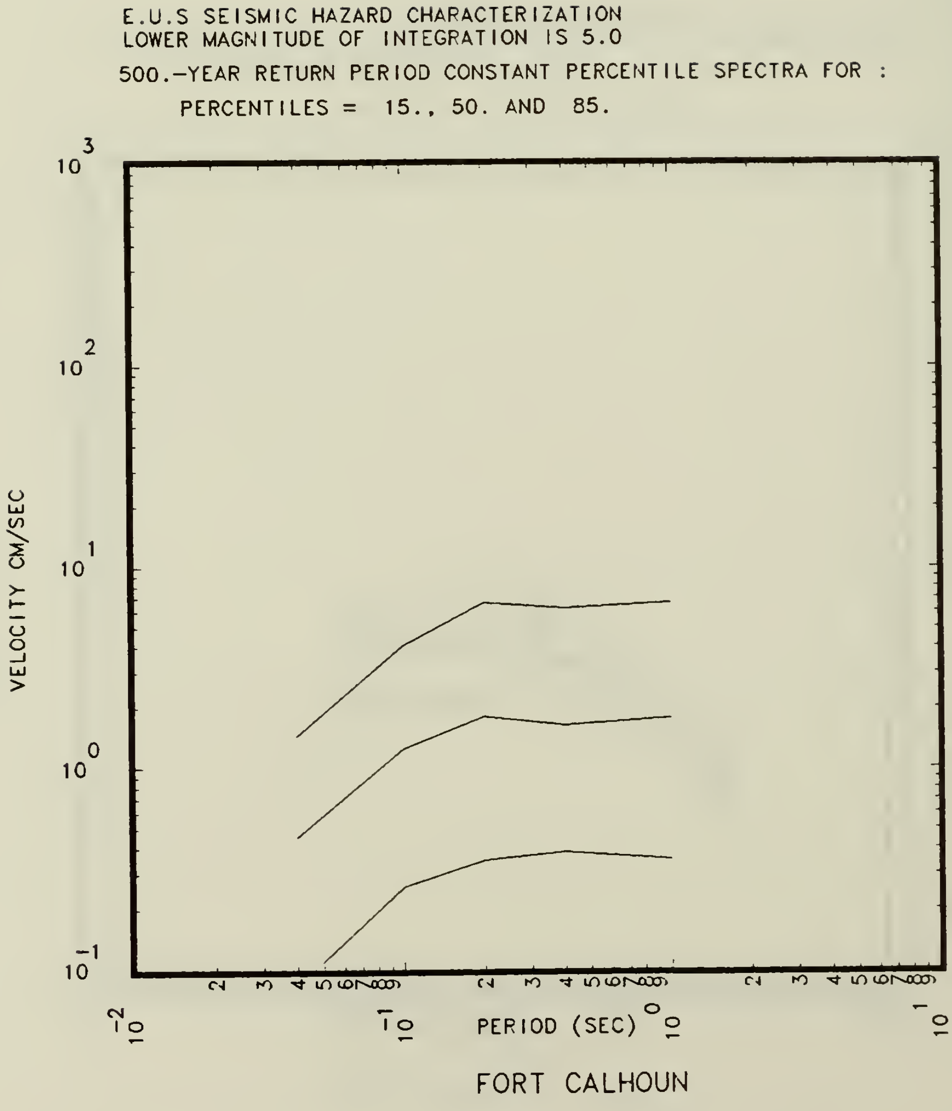

Figure 2.7.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Fort Calhoun site.

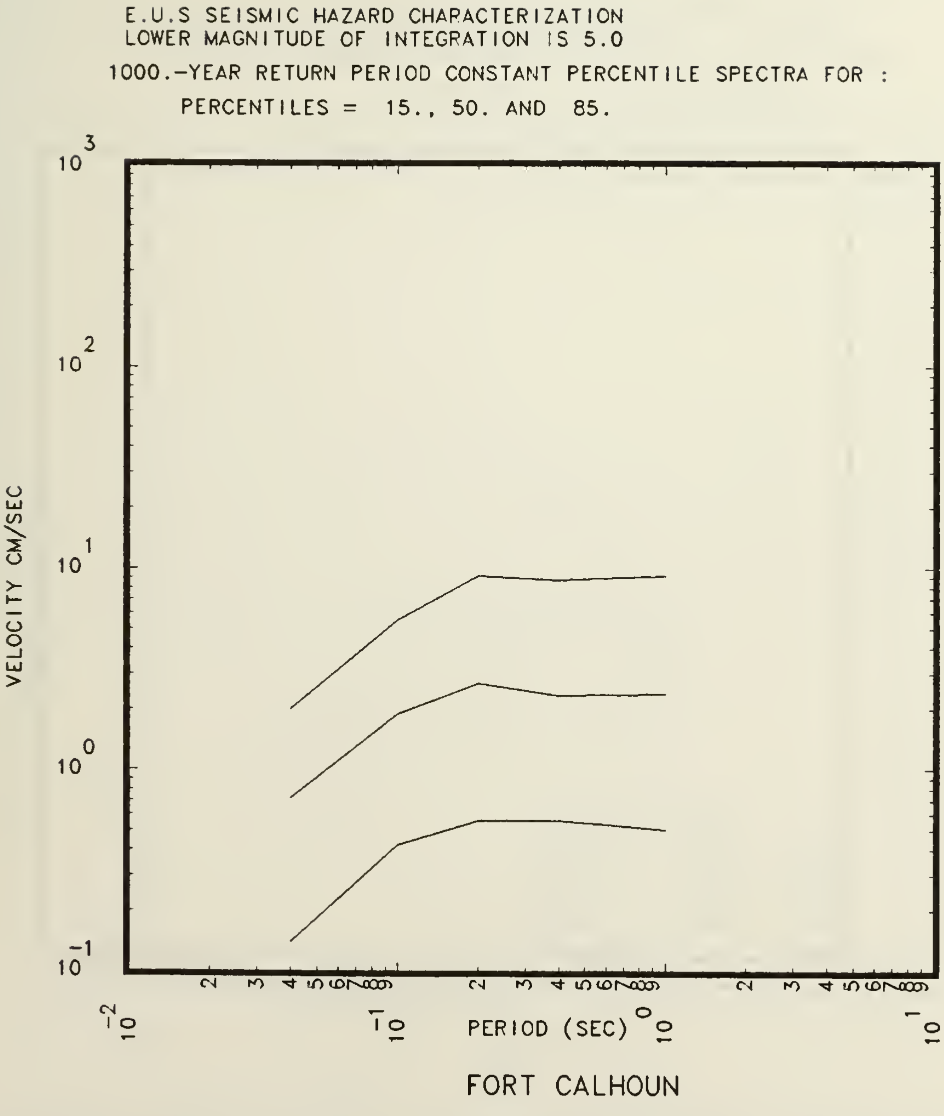

Figure 2.7.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Fort Calhoun site.

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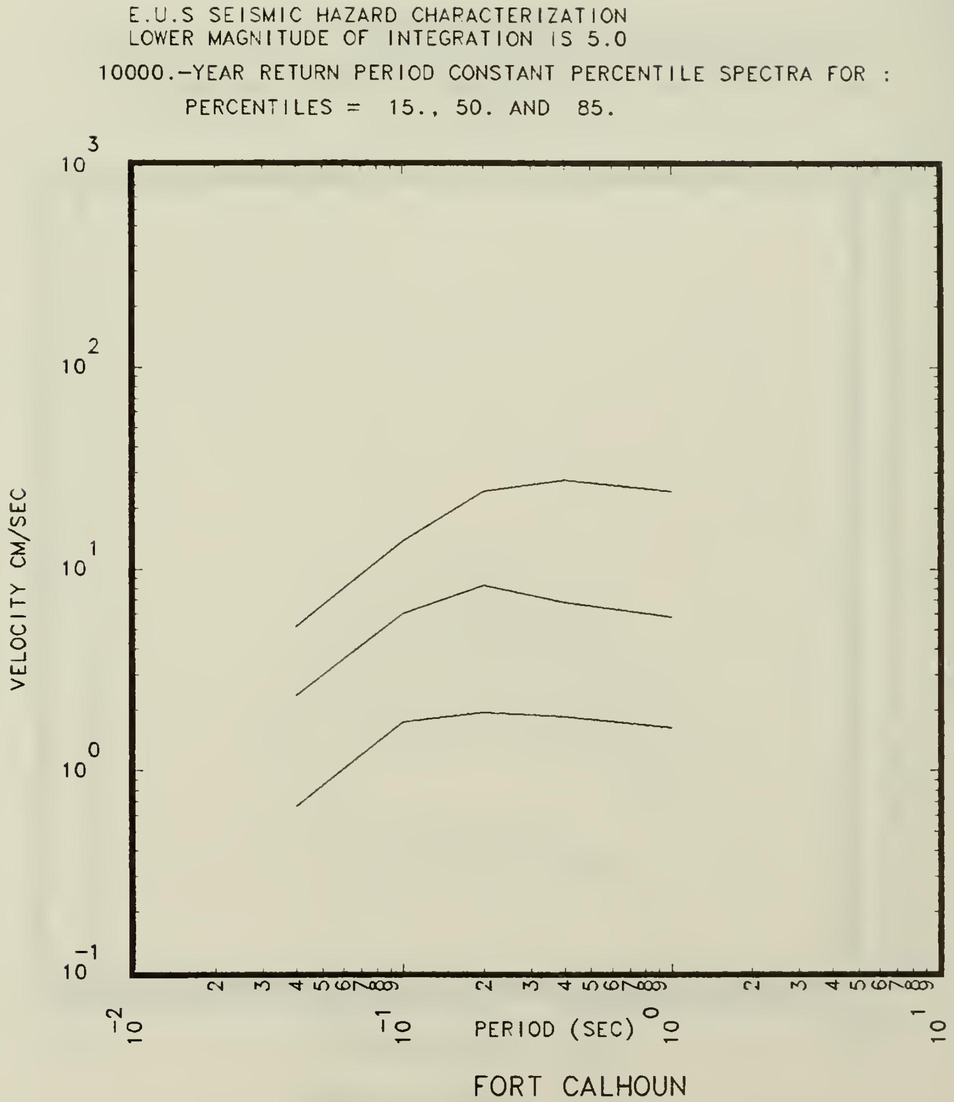


Figure 2.7.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Fort Calhoun site.

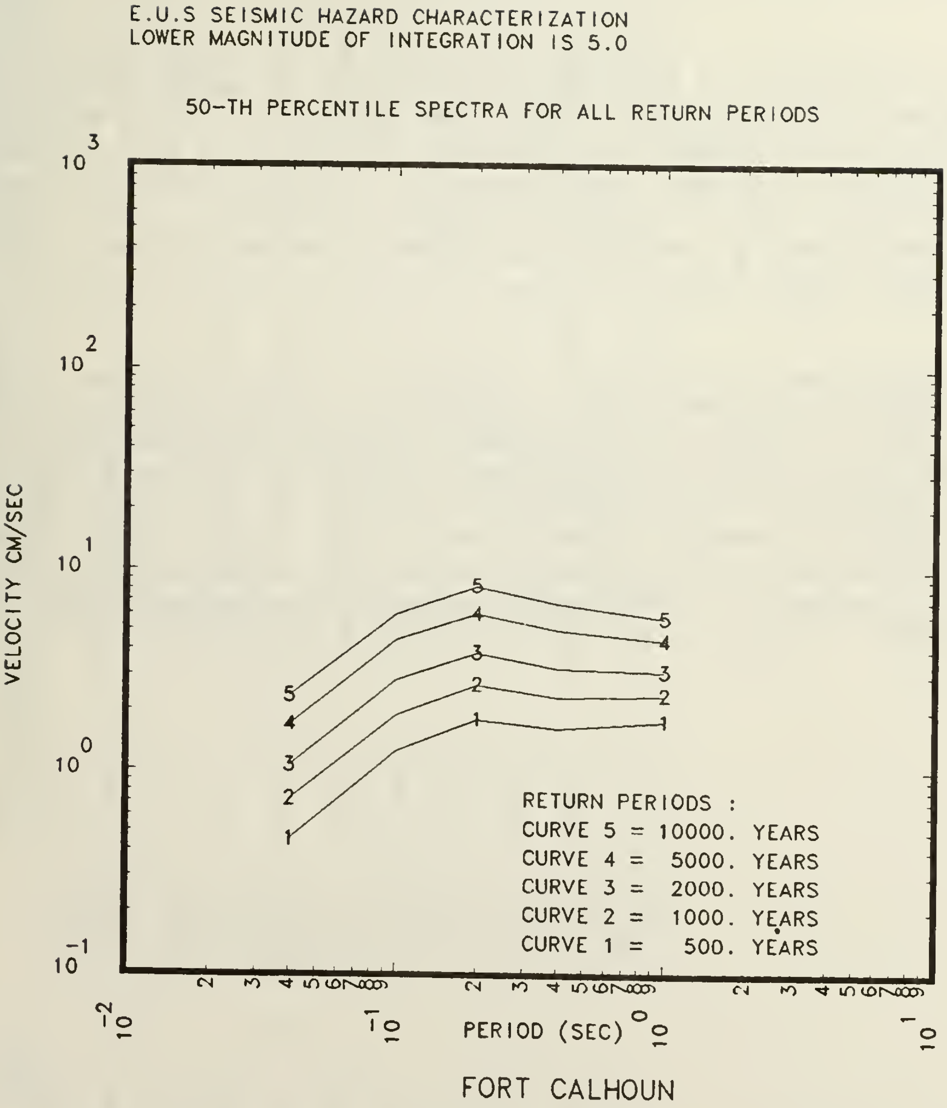


Figure 2.7.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Fort Calhoun site.

2.8 GRAND GULF

Grand Gulf is a deep soil site and is represented by the symbol "8" in Fig. 1.1. Table 2.8.1 and Figs. 2.8.1 to 2.8.10 give the basic results for the Grand Gulf site. Because Grand Gulf is a deep soil site, the G-Expert 5's GM model does not dominate as it does in the case of the rock site (See Section 2.1).

Table 2.8.1 shows that for six S-Experts, the dominant contribution comes from the New Madrid zone. Thus, as expected, a discrimination of the hazard by distance bins shows the clear dominance distant earthquakes in Fig. 2.8.11, (i.e., dominant contribution from earthquakes farther than 150 km of the site).

Similar discrimination of earthquake contribution by magnitude bins shows a clear dominance of earthquakes larger than magnitude 6.5 with much smaller contribution from earthquake in the first bin (i.e. 3.75 to 5.00) at high PGA. By contrast, the small earthquakes (3.75 to 5.00) dominate for PGA smaller than 0.1g. Thus including the small earthquakes in the range up to PGA = 0.1g would modify the BEHC significantly, on the contrary it would not affect the BEHC above 0.1g.

The discussion given in Section 2.4 relative to the spread between the G-Experts' BEHCs per S-Expert holds. Specifically, for S-Experts 3,6,10 and 12 where the hazard is dominated by the host zone the spread between the G-Experts' BEHCs is similar to that shown in Fig. 2.4.11. For S-Experts 2,4,5 and 7 the New Madrid region dominates the hazard and the spread between the G-Experts' BEHCs is similar to that shown in Fig. 2.4.12. For S-Experts 1, 11 and 13, the New Madrid region makes a significant contribution to the hazard, but does not dominate it. For these S-Experts, the spread between the G-Experts' BEHCs is larger than shown in Fig. 2.4.11 but less than in Fig. 2.4.12.

MOST IMPORTANT ZONES PER S-EXPERT FOR GRAND GULF

SITE SOIL CATEGORY DEEP-SOIL

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 1	ZONE ID:	ZONE 1	ZONE 9	ZONE 5	ZONE 10	ZONE 1	ZONE 9	ZONE 5	ZONE 10
		% CONT.:	47.	39.	8.	6.	66.	32.	2.	0.
2	COMP. ZO	ZONE ID:	ZONE 18	COMP. ZON	ZONE 20	ZONE 27	ZONE 18	COMP. ZON	ZONE 1	ZONE 2
		% CONT.:	89.	10.	0.	0.	86.	14.	0.	0.
3	ZONE 10	ZONE ID:	ZONE 10	ZONE 13	ZONE 12	ZONE 14	ZONE 10	ZONE 13	COMP. ZON	ZONE 8A
		% CONT.:	71.	19.	4.	2.	89.	8.	3.	0.
4	ZONE 25	ZONE ID:	ZONE 4	ZONE 25	ZONE 3	ZONE 8	ZONE 4	ZONE 25	ZONE 1	ZONE 2
		% CONT.:	98.	1.	1.	0.	99.	1.	0.	0.
5	COMP. ZO	ZONE ID:	ZONE 15	ZONE 11	COMP. ZON	ZONE 14	ZONE 15	COMP. ZON	ZONE 11	ZONE 8
		% CONT.:	90.	7.	3.	0.	98.	2.	0.	0.
6	ZONE 21	ZONE ID:	ZONE 21	ZONE 18	ZONE 17	COMP. ZON	ZONE 21	ZONE 18	COMP. ZON	ZONE 17
		% CONT.:	50.	18.	15.	8.	88.	6.	4.	2.
7	ZONE 2 =	ZONE ID:	ZONE 6	ZONE 2 =	ZONE 5	ZONE 30	ZONE 6	ZONE 2 =	ZONE 5	ZONE 1
		% CONT.:	89.	8.	2.	0.	91.	9.	0.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 12A	ZONE 29	ZONE 28	ZONE 19 =	ZONE 12A	ZONE 4B	ZONE 13
		% CONT.:	89.	10.	0.	0.	100.	0.	0.	0.
11	ZONE 14	ZONE ID:	ZONE 11	ZONE 14	ZONE 15	ZONE 10	ZONE 14	ZONE 11	CZ = ZONE	ZONE 10
		% CONT.:	46.	34.	7.	6.	52.	44.	2.	1.
12	ZONE 11	ZONE ID:	ZONE 11	ZONE 15	ZONE 14	ZONE 3	ZONE 11	ZONE 15	ZONE 3	ZONE 14
		% CONT.:	80.	12.	4.	1.	87.	13.	0.	0.
13	CZ 16	ZONE ID:	ZONE 5	CZ 16	CZ 15	ZONE 4	ZONE 5	CZ 16	CZ 15	ZONE 1
		% CONT.:	68.	29.	2.	1.	55.	25.	20.	0.

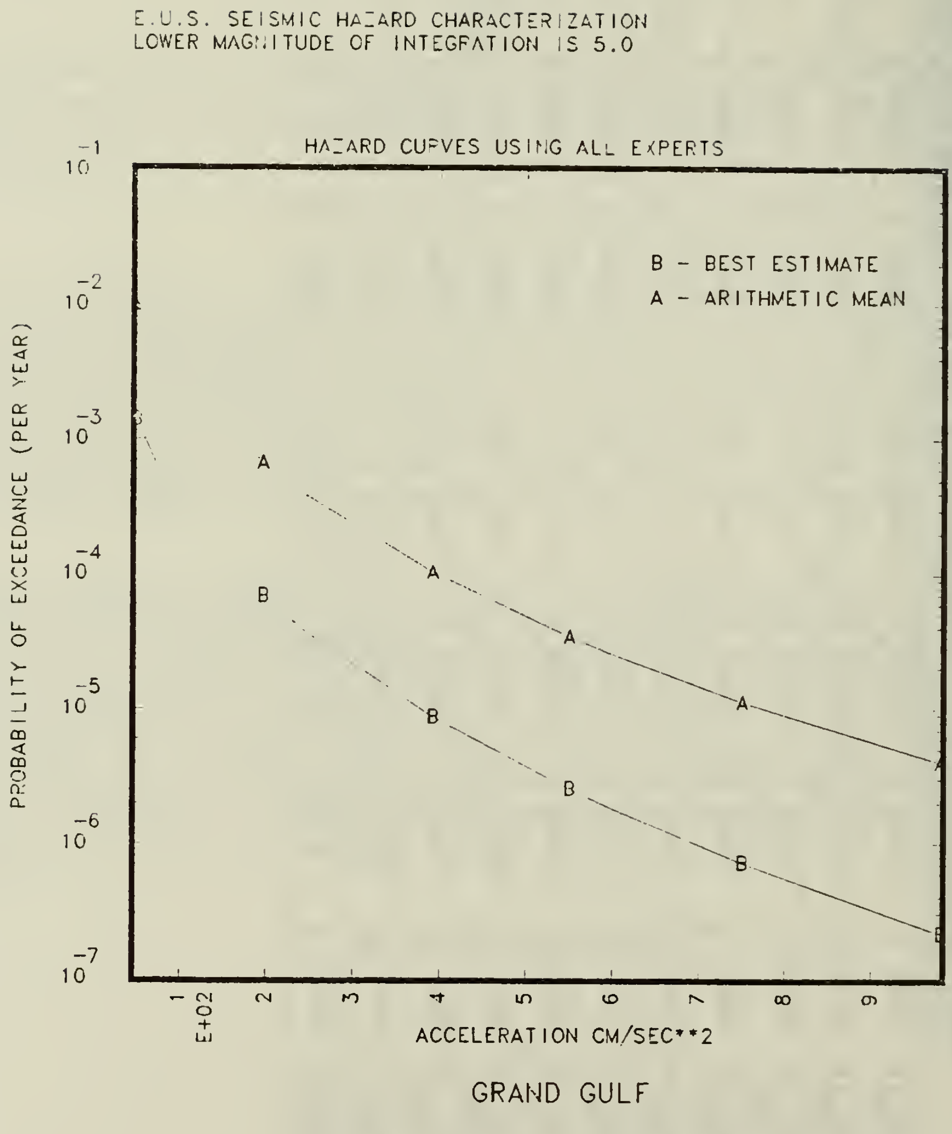


Figure 2.8.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Grand Gulf site.

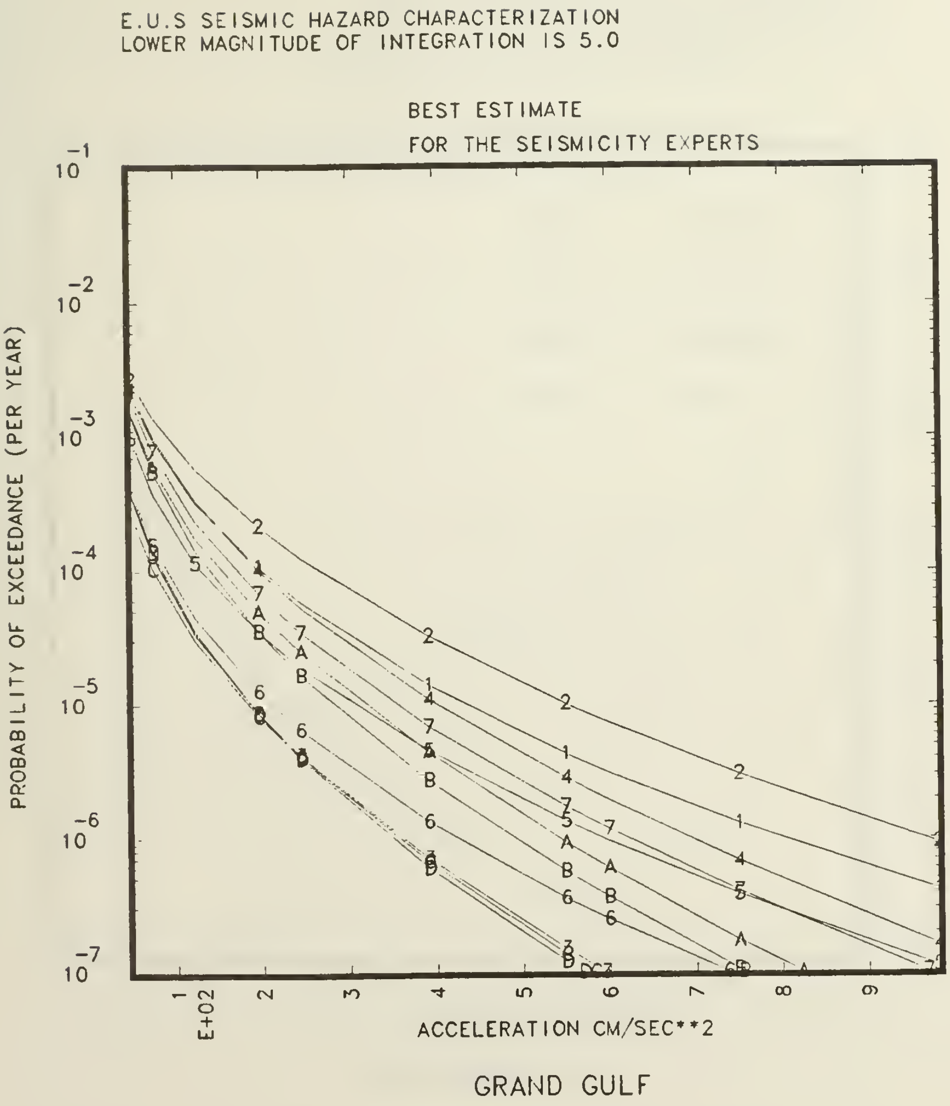


Figure 2.8.2 BEHCs per S-Expert combined over all G-Experts for the Grand Gulf site. Plot symbols given in Table 2.0.

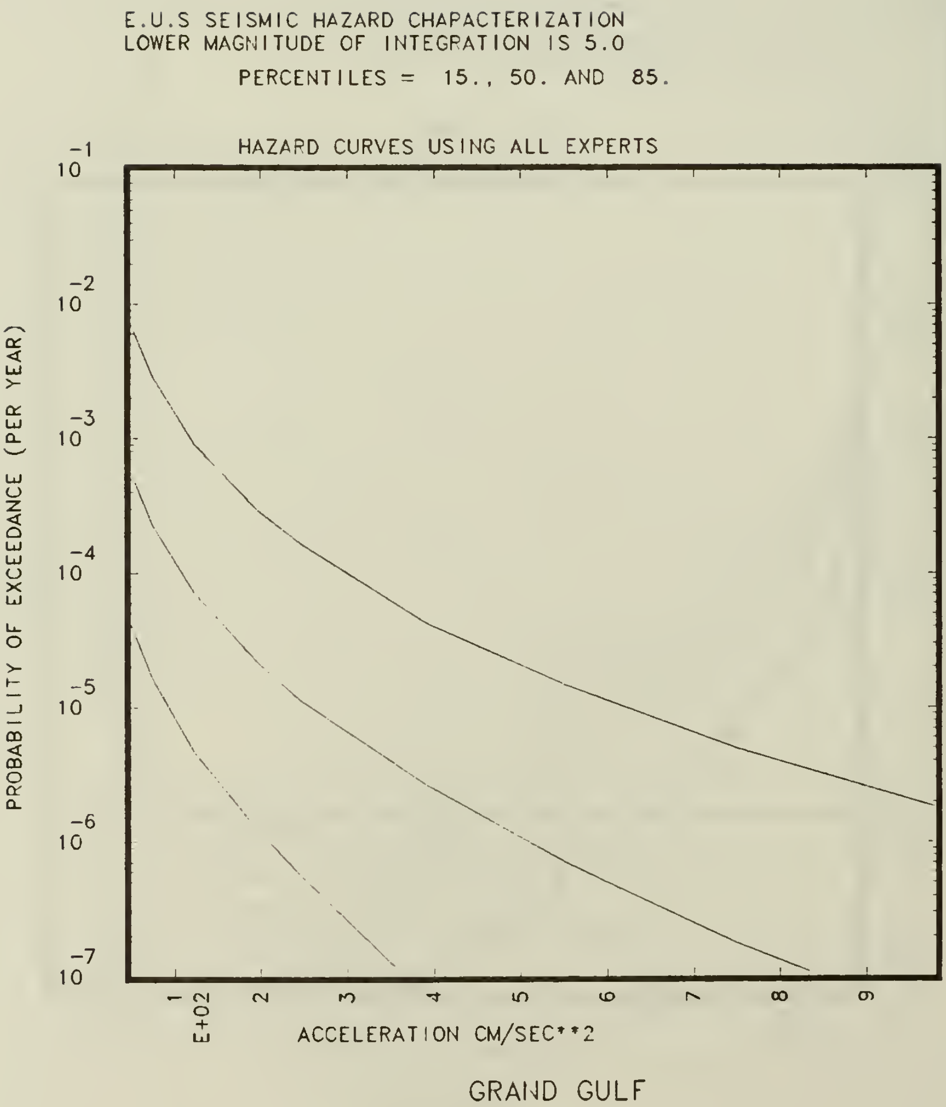


Figure 2.8.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Grand Gulf site.

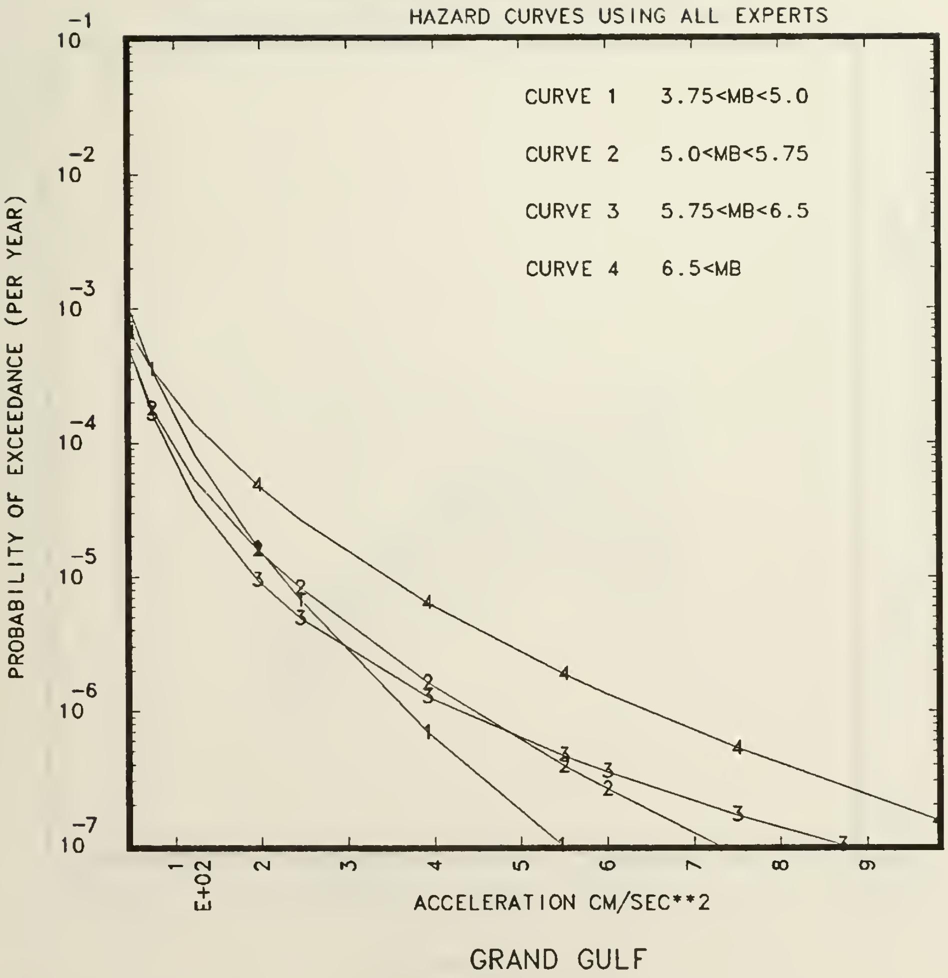


Figure 2.8.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Grand Gulf site.

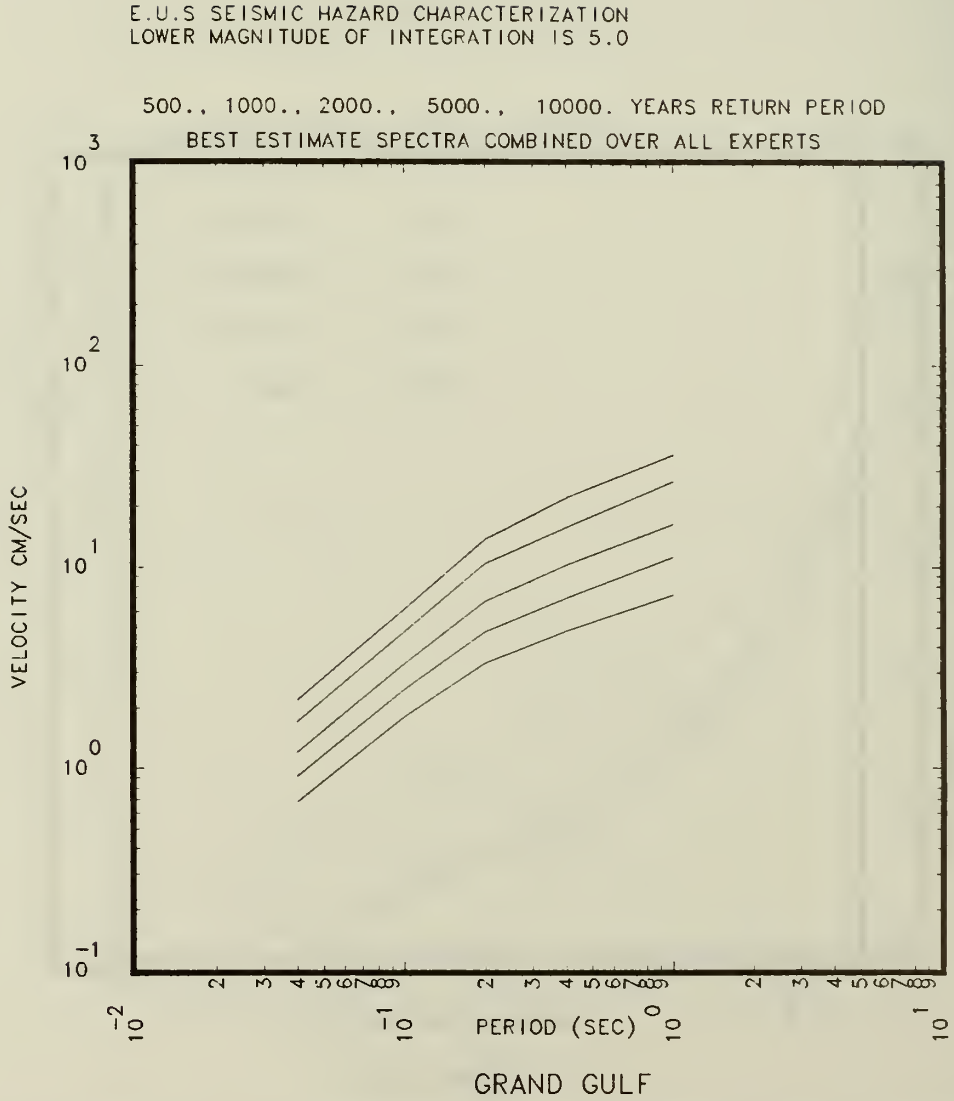


Figure 2.8.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Grand Gulf site.

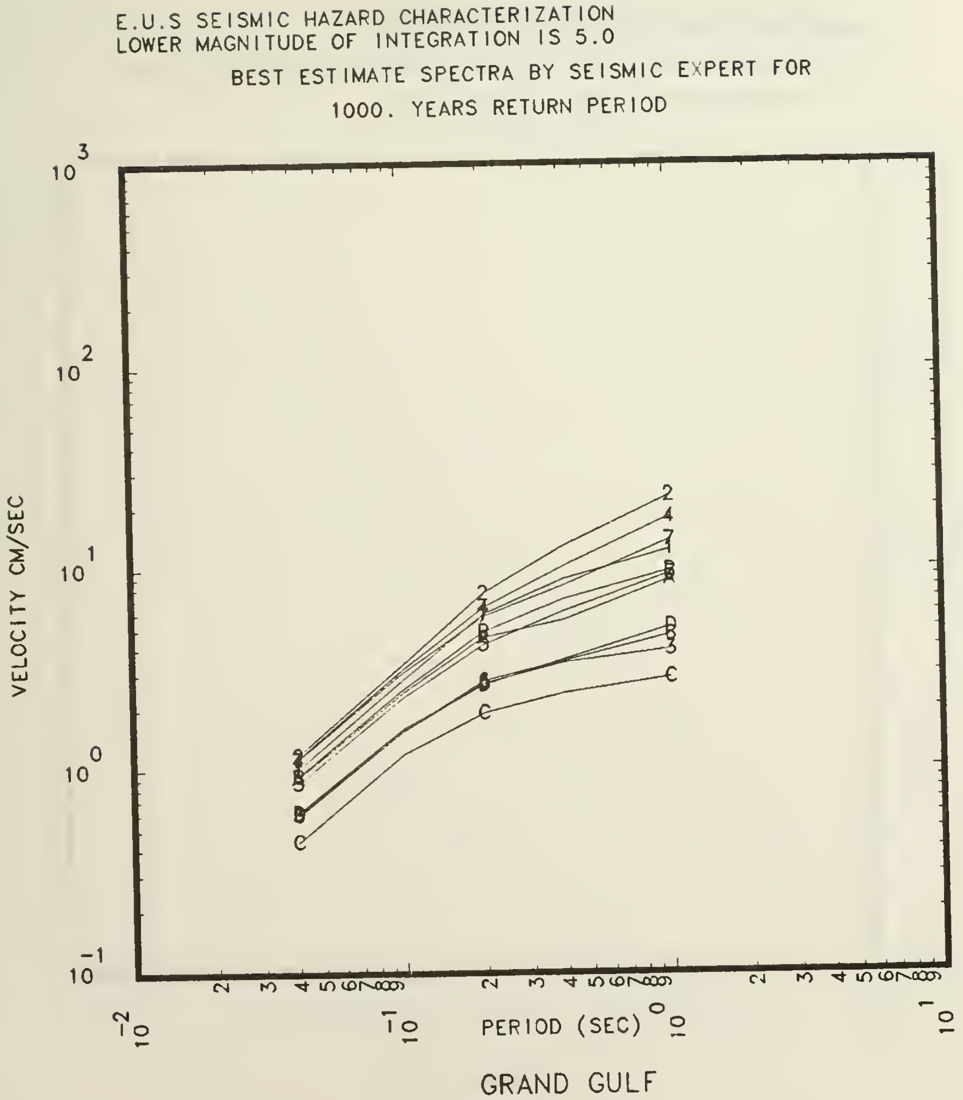


Figure 2.8.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Grand Gulf site. Plot symbols are given in Table 2.0.

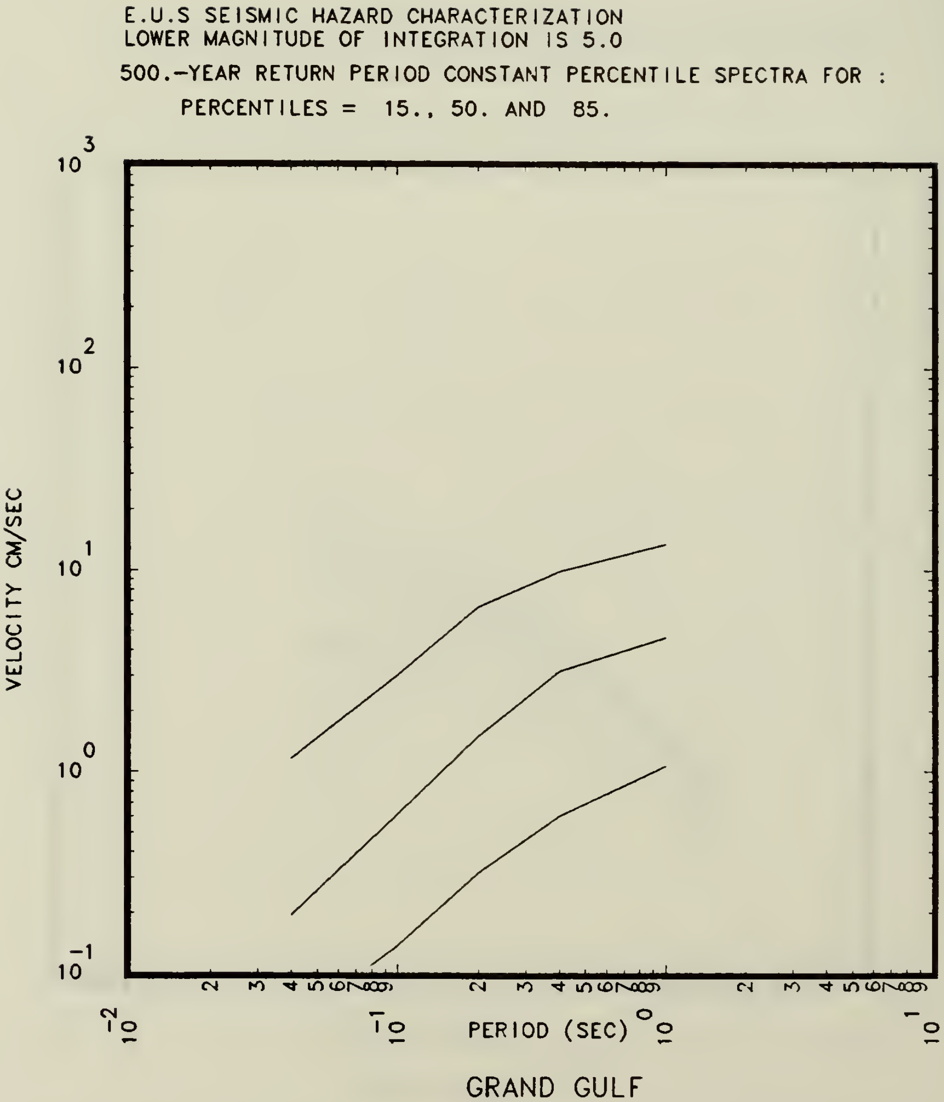


Figure 2.8.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Grand Gulf site.

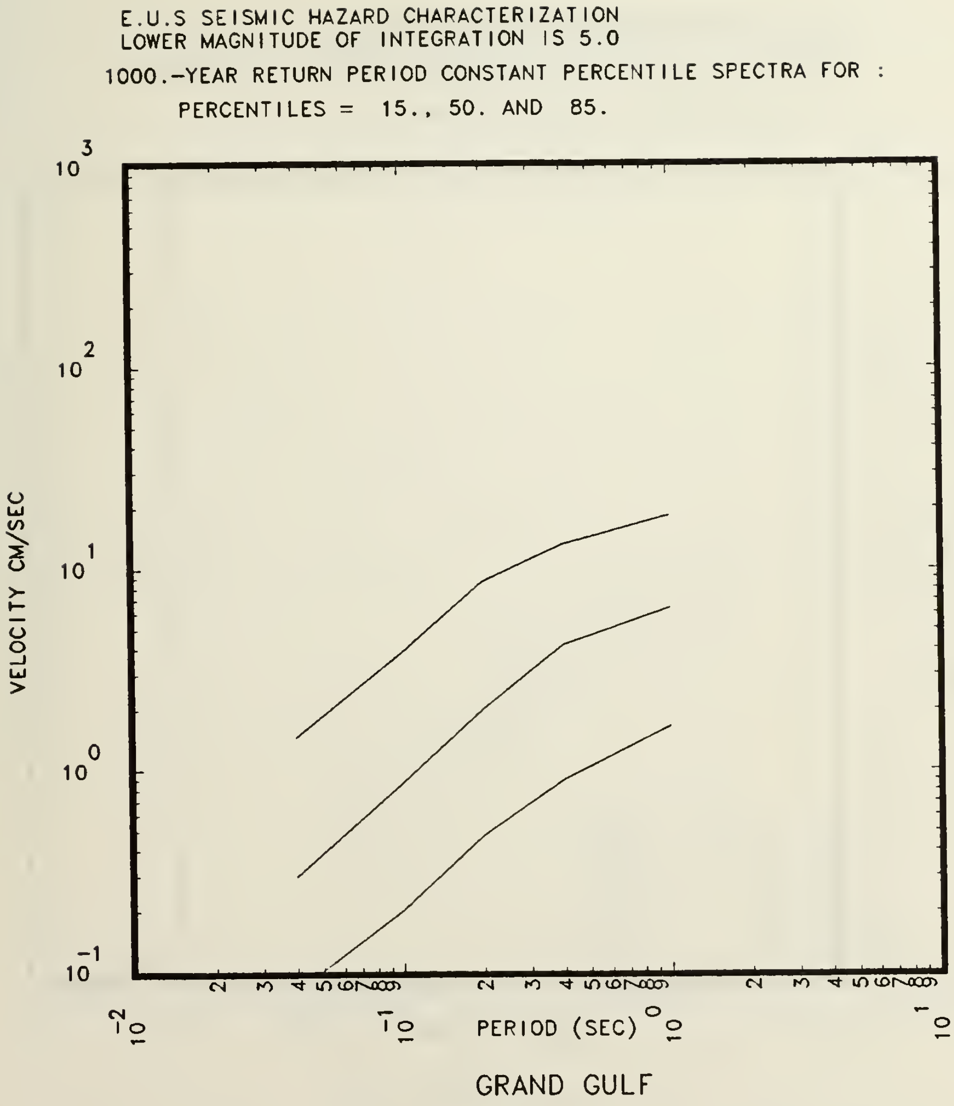


Figure 2.8.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Grand Gulf site.

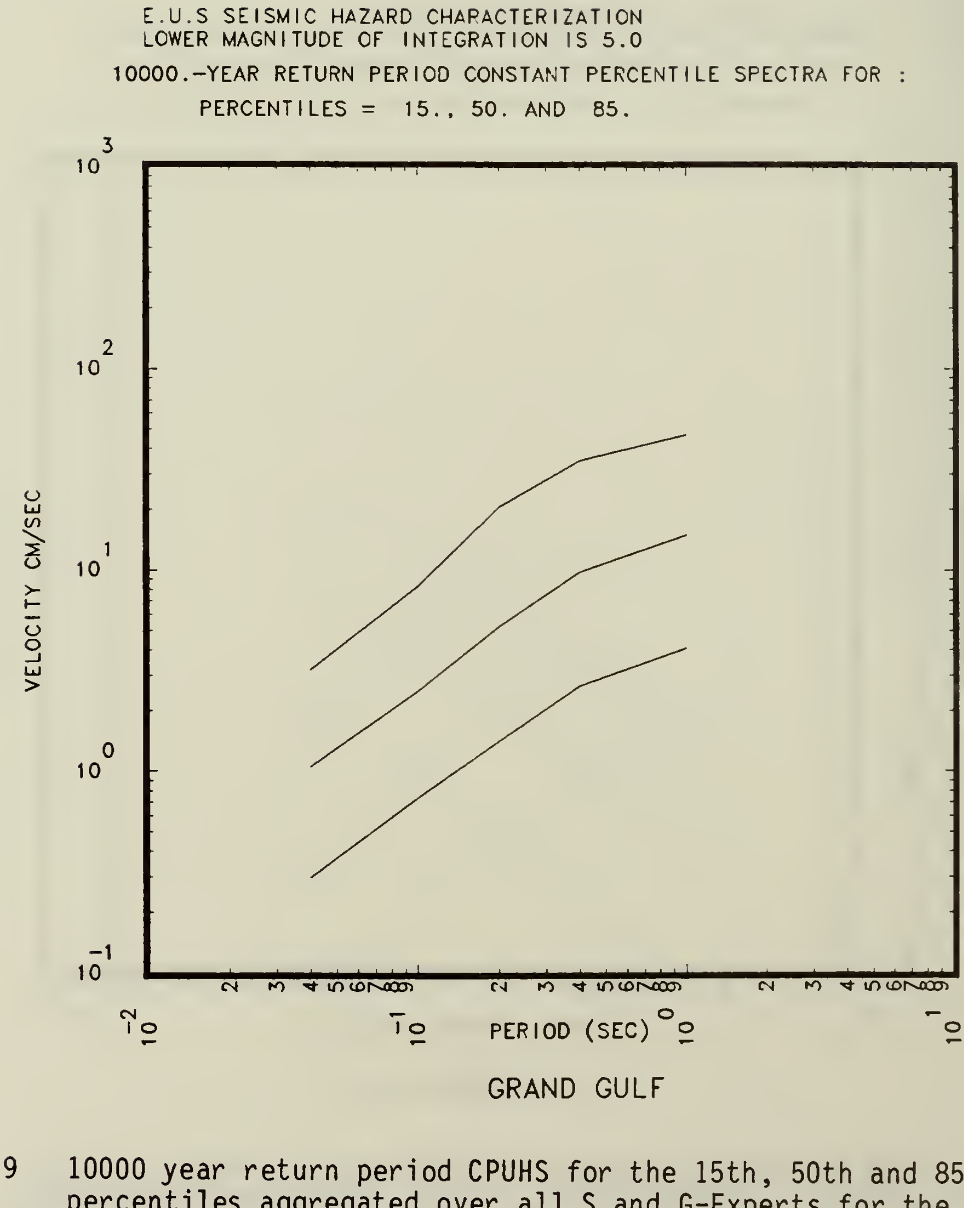


Figure 2.8.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Grand Gulf site.

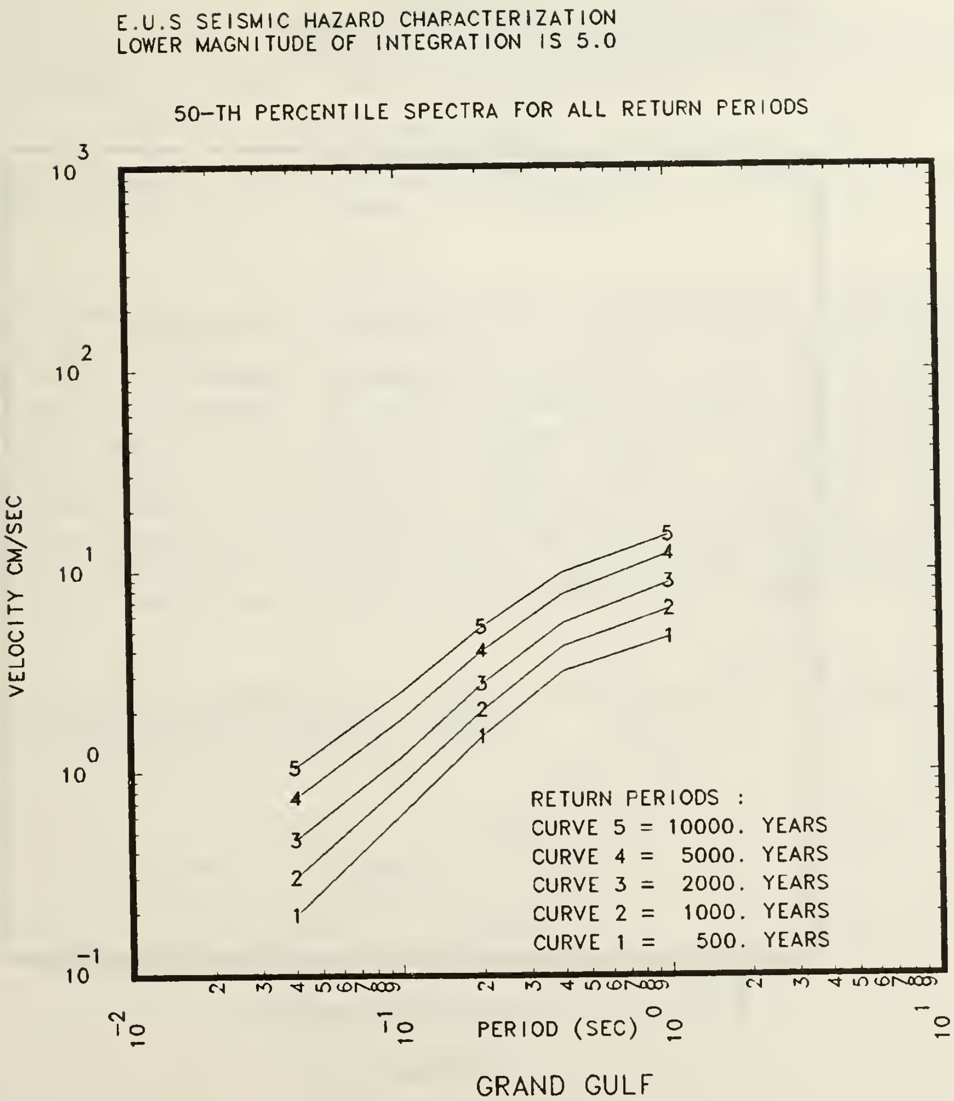


Figure 2.8.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Grand Gulf site.

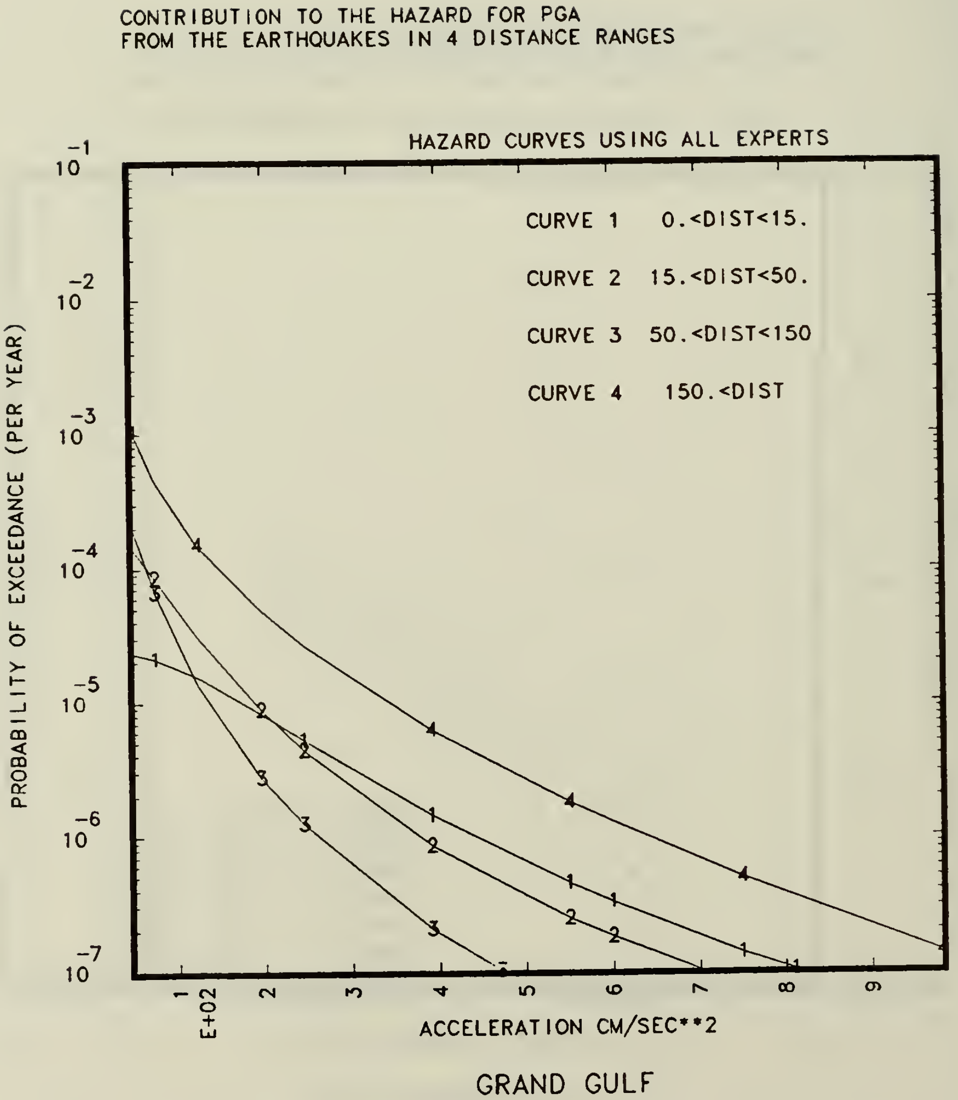


Figure 2.8.11 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated distance ranges for the Grand Gulf site.

2.9 LACROSSE

LaCrosse was placed in the sand-2 (see table 1.4) category. It is located in region 3 (North Central) and is represented by the symbol "9" on the location map (Fig. 1.1). Table 2.9.1 and Figs. 2.9.1 to 2.9.10 give the basic results for the LaCrosse site.

We see from the maps of the various S-Experts that this site is located relatively far from the zones representing the New Madrid zone as modeled by most S-Experts. For most S-Experts the site falls in the unzoned CZ. Thus, the New Madrid zone plays an important role for most S-Experts. However, for most S-Experts the host zone is the zone which dominates the hazard.

Figure 2.9.1 shows typical results. In addition, the BEHC is close to the median and the AMHC is higher than the 85th percentile, (see Fig. 2.9.3).

Figure 2.9.2 indicates that the diversity of opinion, as measured by the spread of the BEHC for all S-Experts, is typical.

Figure 2.9.4 shows the relative contribution of earthquakes in several ranges of magnitude. We see from Fig. 2.9.4 that consistent with the observation that most of the hazard is coming from the host zone that up to approximately 0.2g, the hazard would be dominated by small magnitude earthquakes, but beyond this value, the earthquakes in the lowest bin (magnitude 3.75 to 5) would not contribute significantly to the total hazard. The small to median ($m_b < 5.75$) earthquakes dominate the total hazard. Adding the contribution of earthquakes with magnitudes between 3.75 and 5. would increase the hazard by a factor of approximately 3 for PGA values below 0.25g. Beyond 0.5g including earthquakes in the 3.75 to 5. range would not have any effect on the BEHC for PGA.

The discussions given in Sections 2.4 and 2.8 relative to the spread between the G-Experts' BEHCs holds for this site.

TABLE 2.9.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR LA CROSSE

SITE SOIL CATEGORY SAND-2

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 15	ZONE ID:	ZONE 9	ZONE 15	ZONE 11	ZONE 10	ZONE 15	ZONE 9	ZONE 11	ZONE 10
		% CONT.:	41.	23.	18.	14.	66.	26.	5.	2.
2	COMP. ZO	ZONE ID:	ZONE 18	COMP. ZON	ZONE 20	ZONE 21	COMP. ZON	ZONE 18	ZONE 6	ZONE 13
		% CONT.:	63.	34.	2.	1.	73.	27.	0.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 13	ZONE 12	ZONE 15	COMP. ZON	ZONE 13	ZONE 15	ZONE 2
		% CONT.:	88.	5.	4.	3.	100.	0.	0.	0.
4	COMP. ZO	ZONE ID:	ZONE 6	ZONE 4	COMP. ZON	ZONE 5	ZONE 6	ZONE 4	COMP. ZON	ZONE 13
		% CONT.:	66.	29.	2.	1.	90.	6.	4.	1.
5	COMP. ZO	ZONE ID:	ZONE 15	COMP. ZON	ZONE 13	ZONE 12	COMP. ZON	ZONE 15	ZONE 4	ZONE 5
		% CONT.:	71.	23.	3.	2.	53.	47.	0.	0.
6	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 17	ZONE 22	ZONE 18	COMP. ZON	ZONE 17	ZONE 22	ZONE 18
		% CONT.:	63.	22.	8.	6.	98.	1.	0.	0.
7	ZONE 3	ZONE ID:	ZONE 6	ZONE 3	ZONE 5	ZONE 2 =	ZONE 3	ZONE 6	ZONE 2 =	ZONE 4
		% CONT.:	73.	24.	1.	1.	70.	29.	1.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 12A	ZONE 26A	ZONE 32	ZONE 19 =	ZONE 10	ZONE 12A	ZONE 13
		% CONT.:	98.	1.	1.	0.	100.	0.	0.	0.
11	CZ = ZON	ZONE ID:	CZ = ZONE	ZONE 10	ZONE 11	ZONE 17	CZ = ZONE	ZONE 10	ZONE 9	ZONE 11
		% CONT.:	95.	4.	1.	0.	100.	0.	0.	0.
12	ZONE 4 =	ZONE ID:	ZONE 15	ZONE 14	ZONE 13	ZONE 31A	ZONE 15	ZONE 5	ZONE 6	ZONE 7
		% CONT.:	71.	14.	12.	3.	100.	0.	0.	0.
13	CZ 15	ZONE ID:	CZ 15	ZONE 5	ZONE 6	ZONE 4	CZ 15	ZONE 5	ZONE 3	ZONE 4
		% CONT.:	93.	6.	0.	0.	100.	0.	0.	0.

E.U.S. SEISMIC HAZARD CHARACTERIZATION
LOWER MAGNITUDE OF INTEGRATION IS 5.0

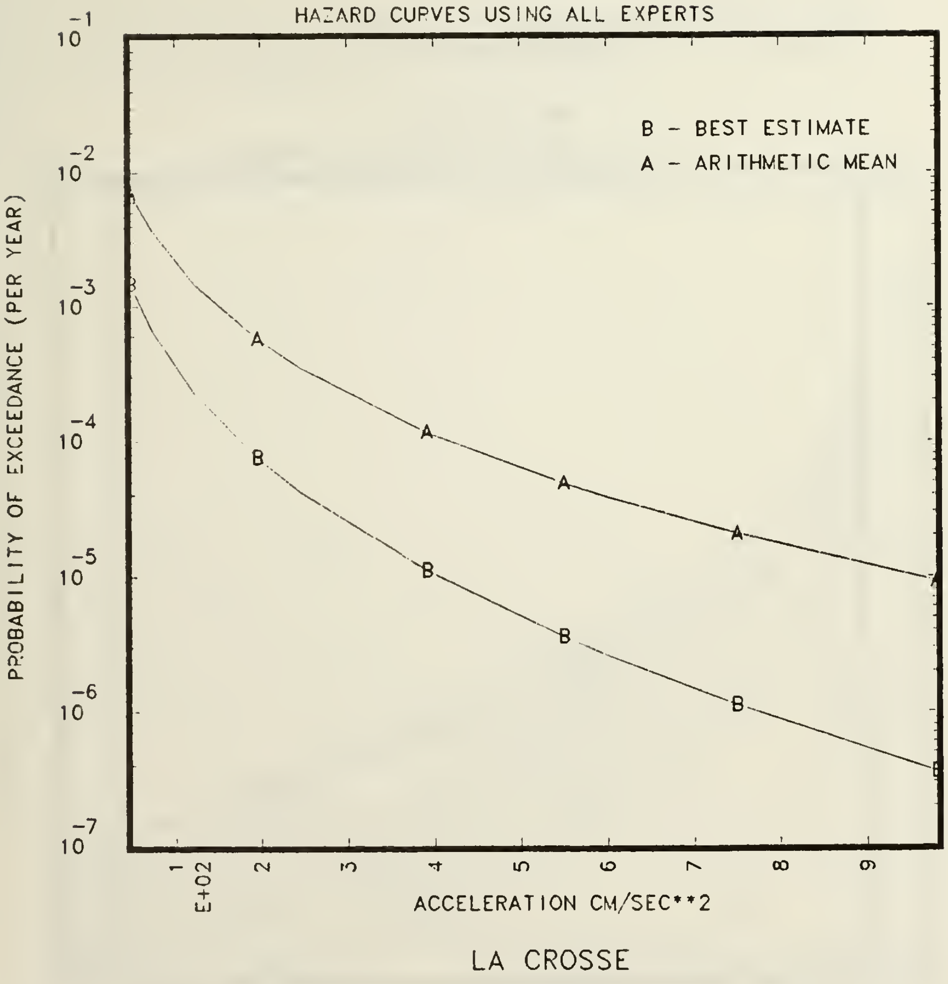


Figure 2.9.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the LaCrosse site.

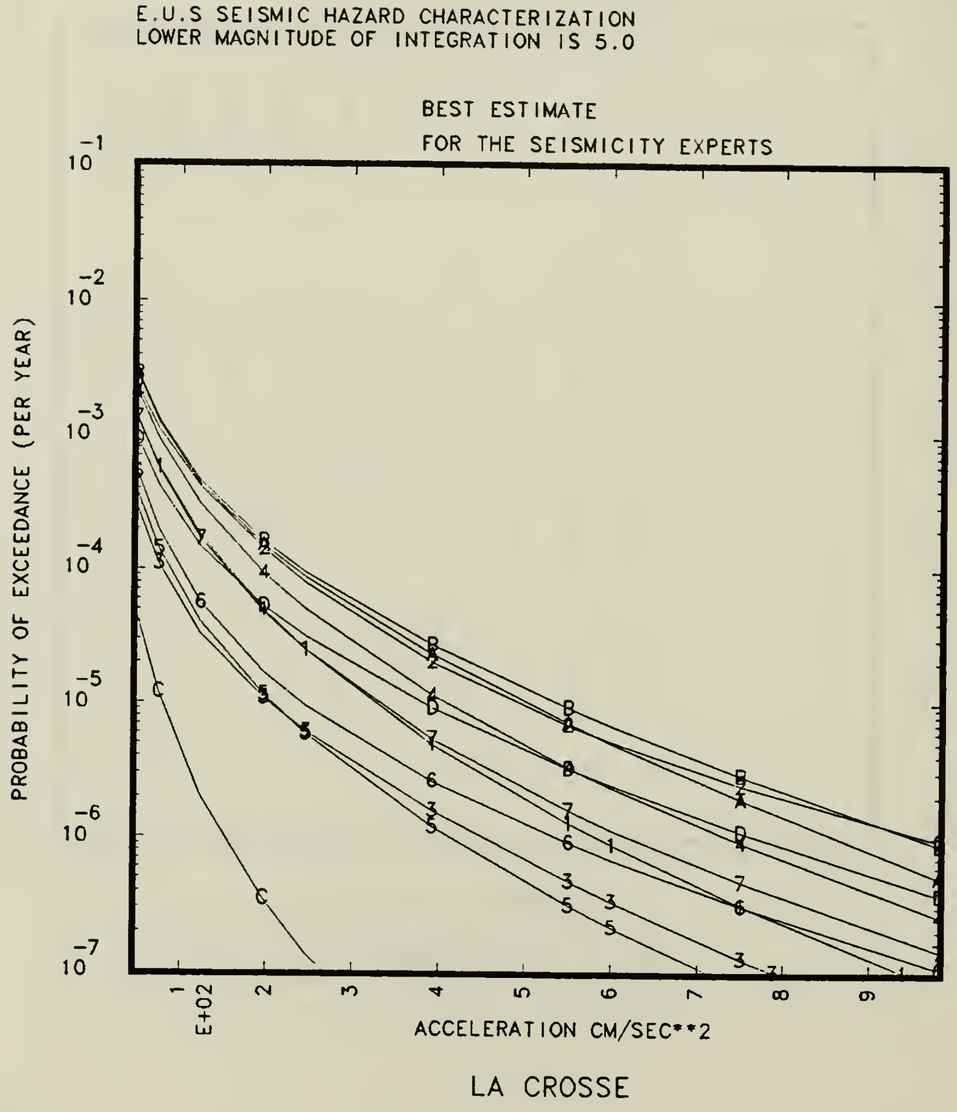


Figure 2.9.2 BEHCs per S-Expert combined over all G-Experts for the LaCrosse site. Plot symbols given in Table 2.0.

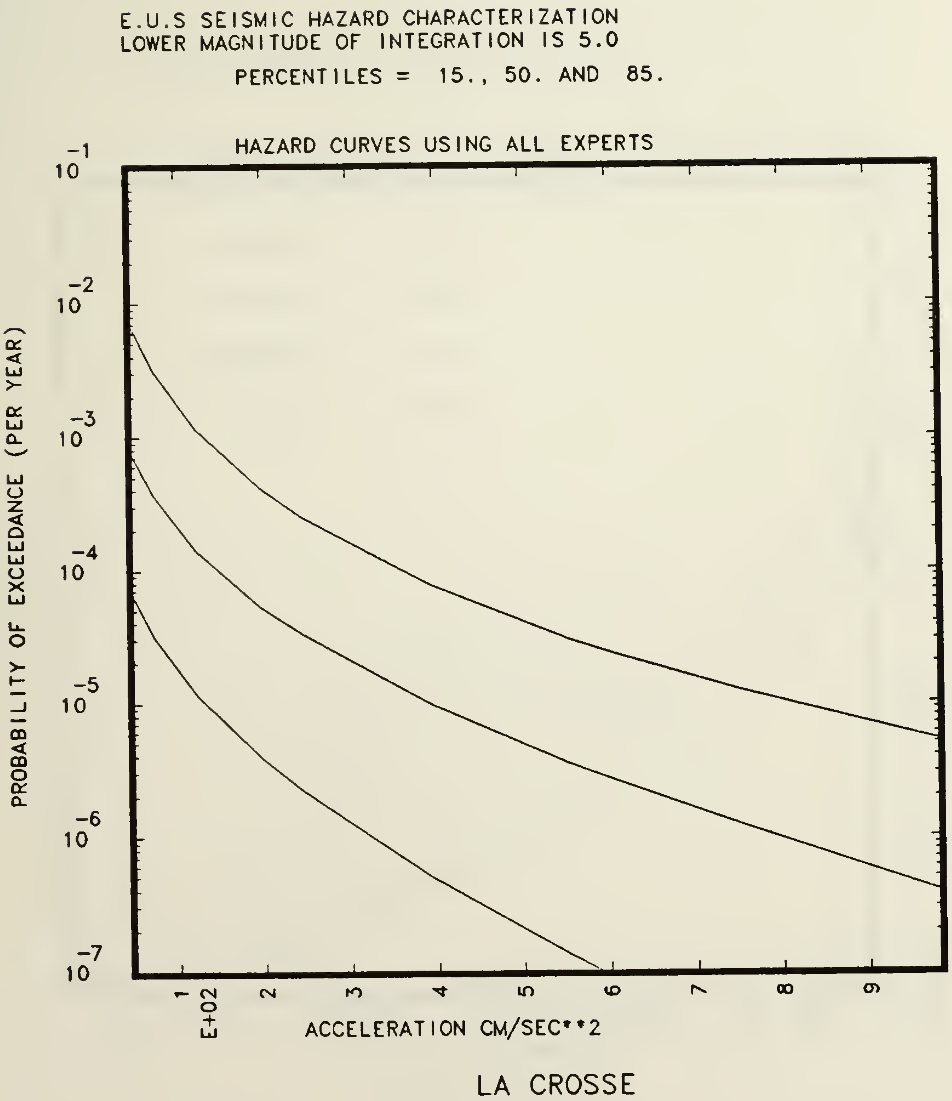


Figure 2.9.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the LaCrosse site.

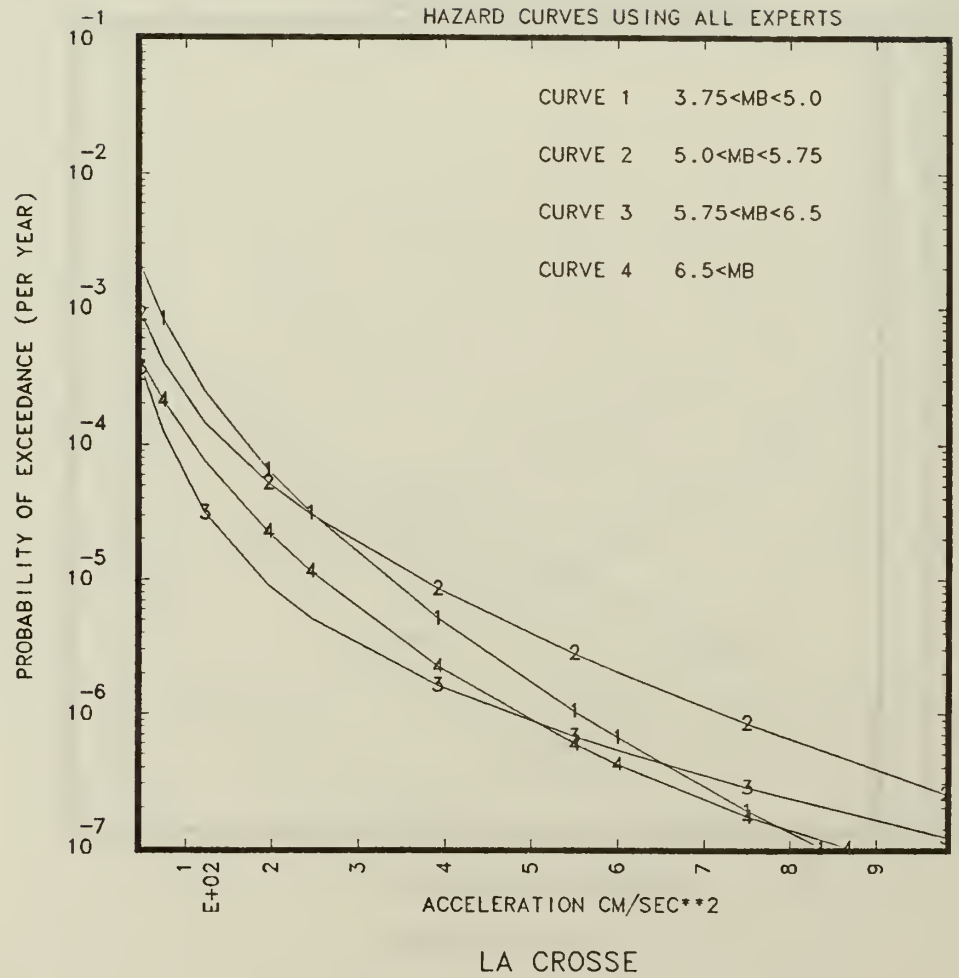


Figure 2.9.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the LaCrosse site.

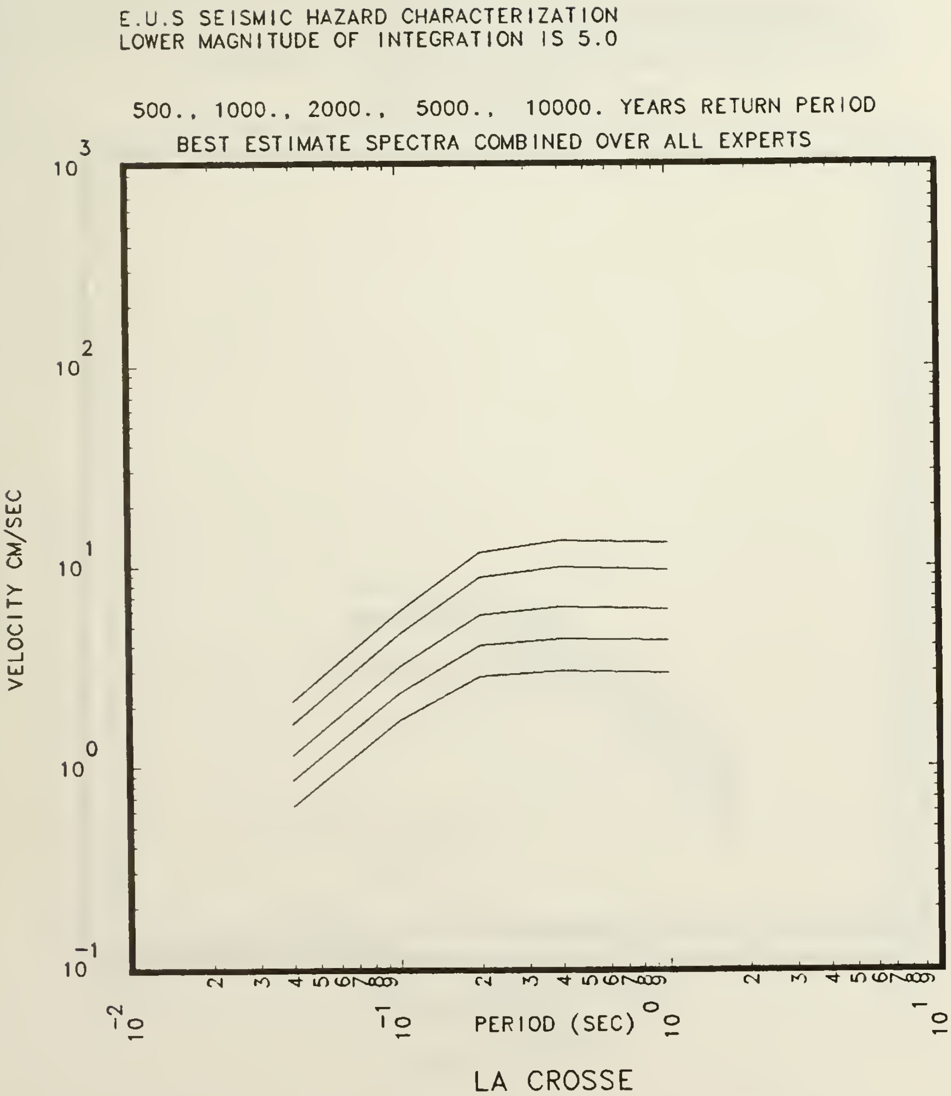


Figure 2.9.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the LaCrosse site.

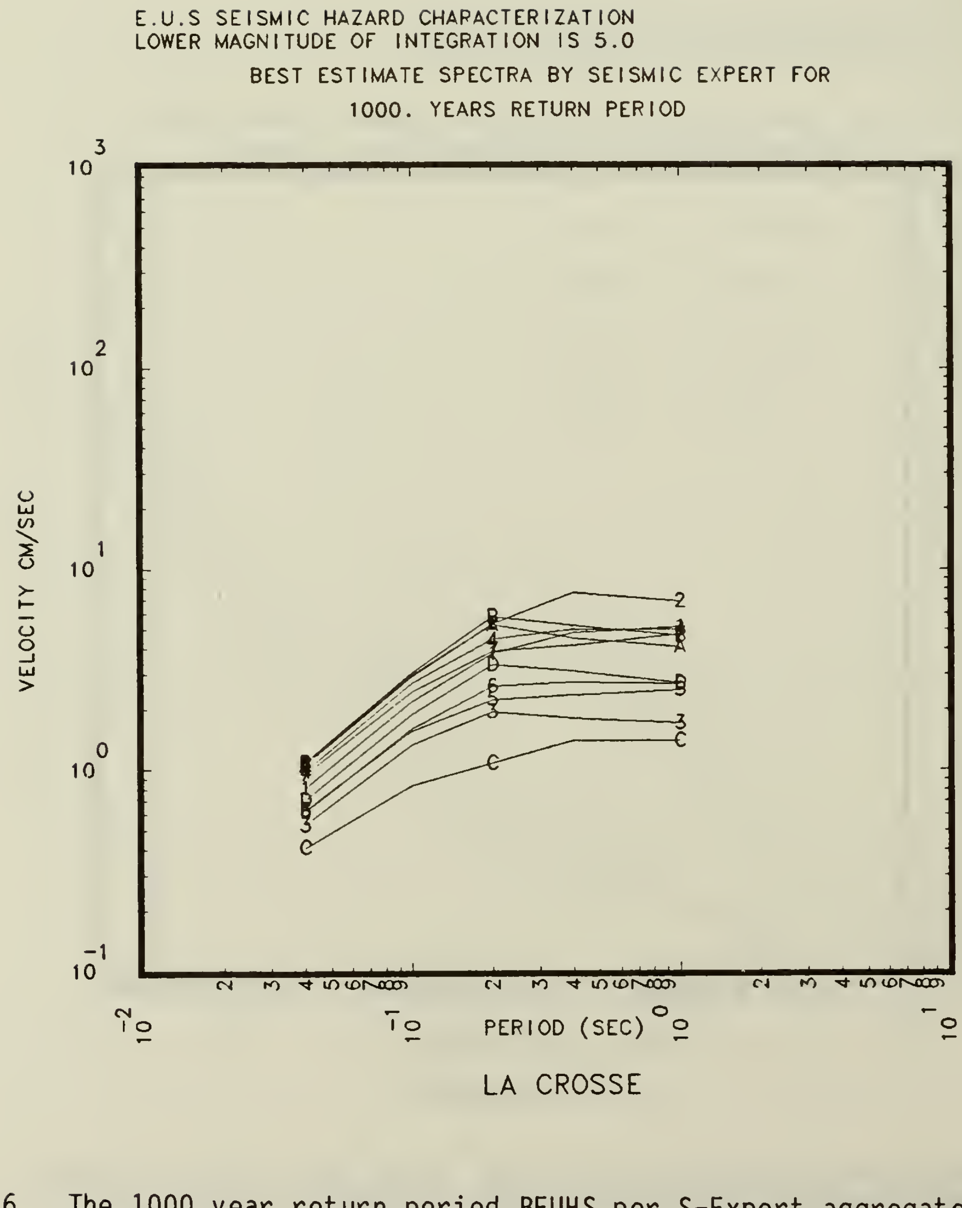


Figure 2.9.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the LaCrosse site. Plot symbols are given in Table 2.0.

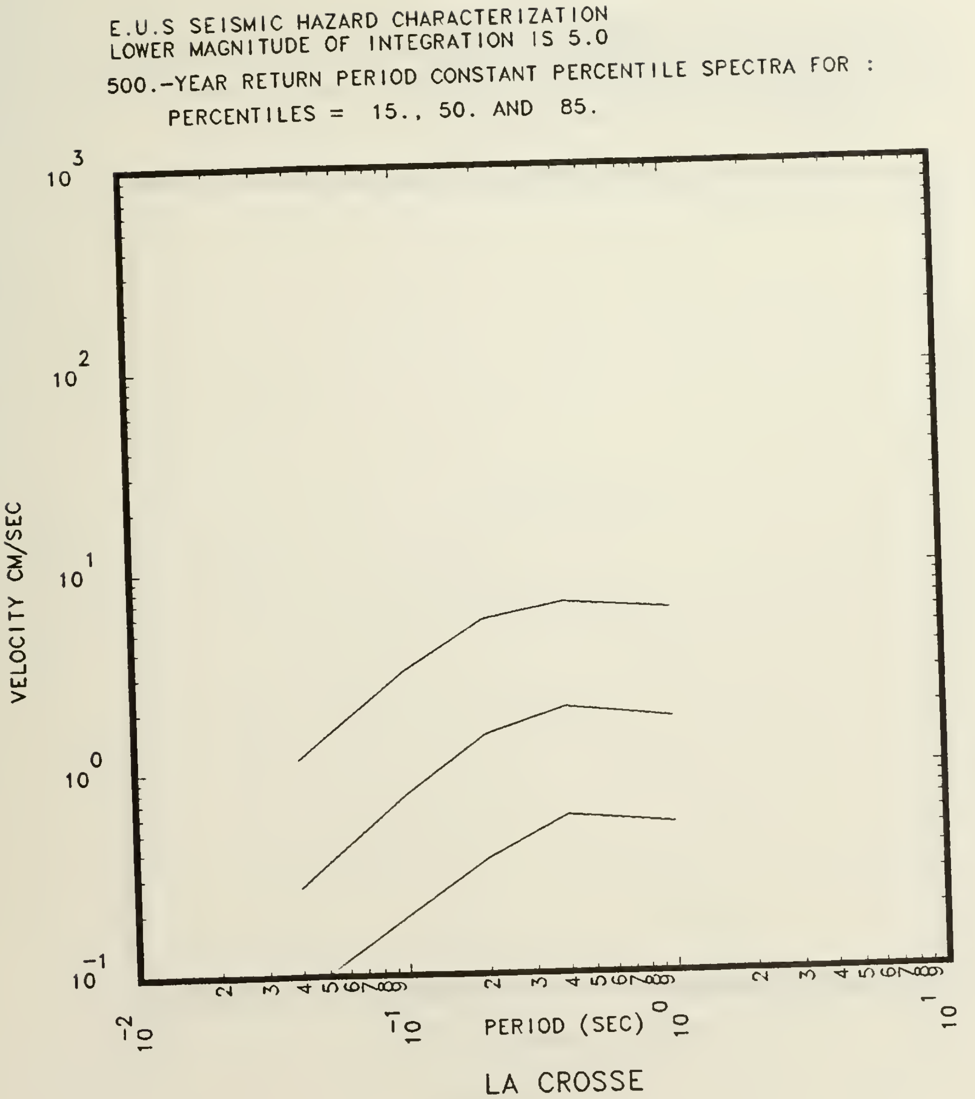


Figure 2.9.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the LaCrosse site.

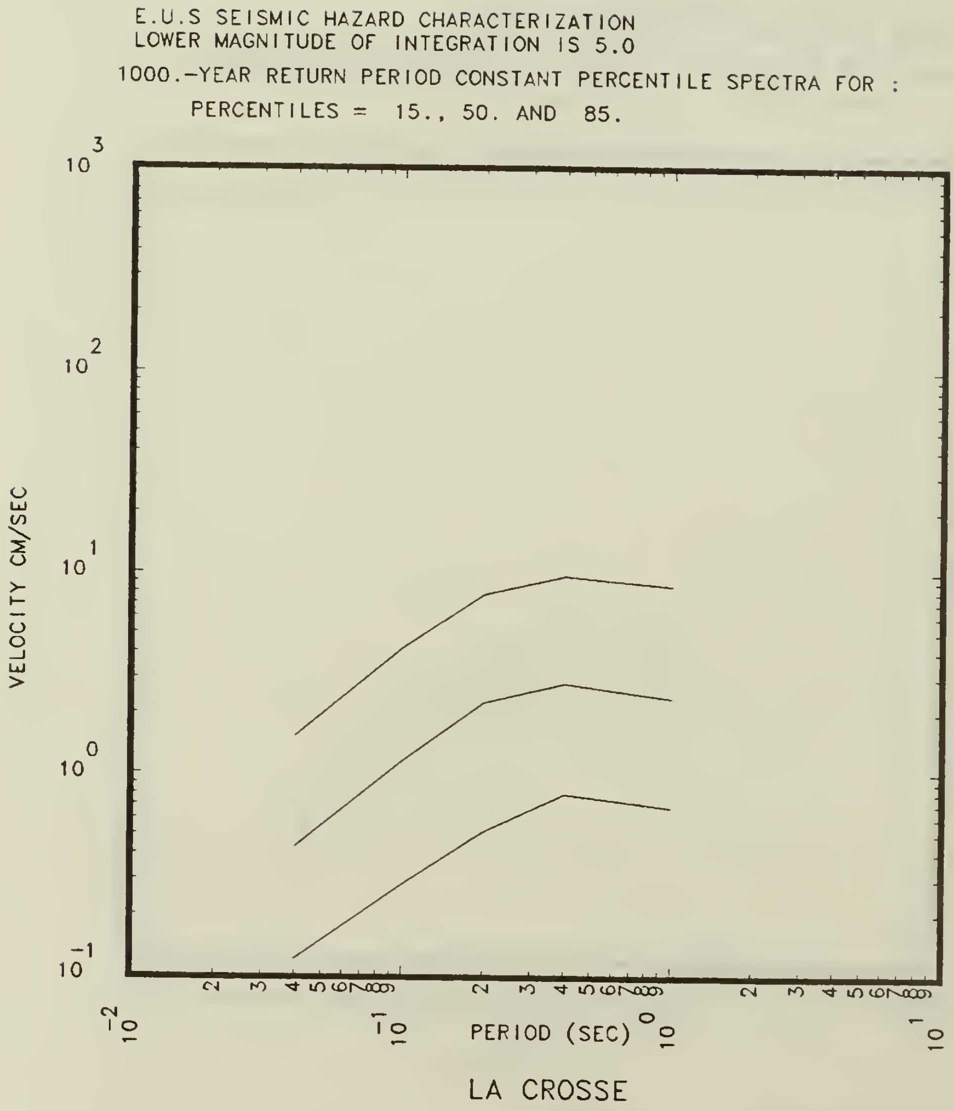


Figure 2.9.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the LaCrosse site.

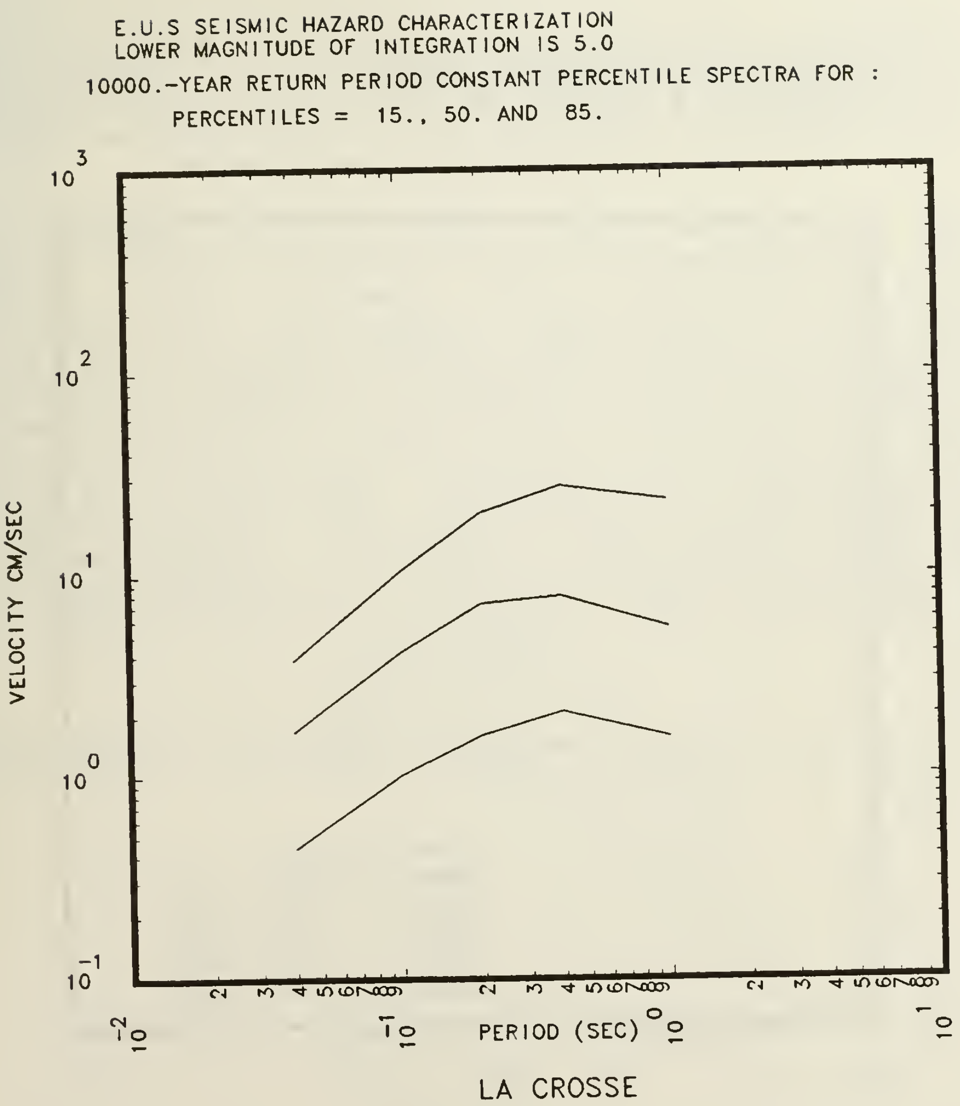


Figure 2.9.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the LaCrosse site.

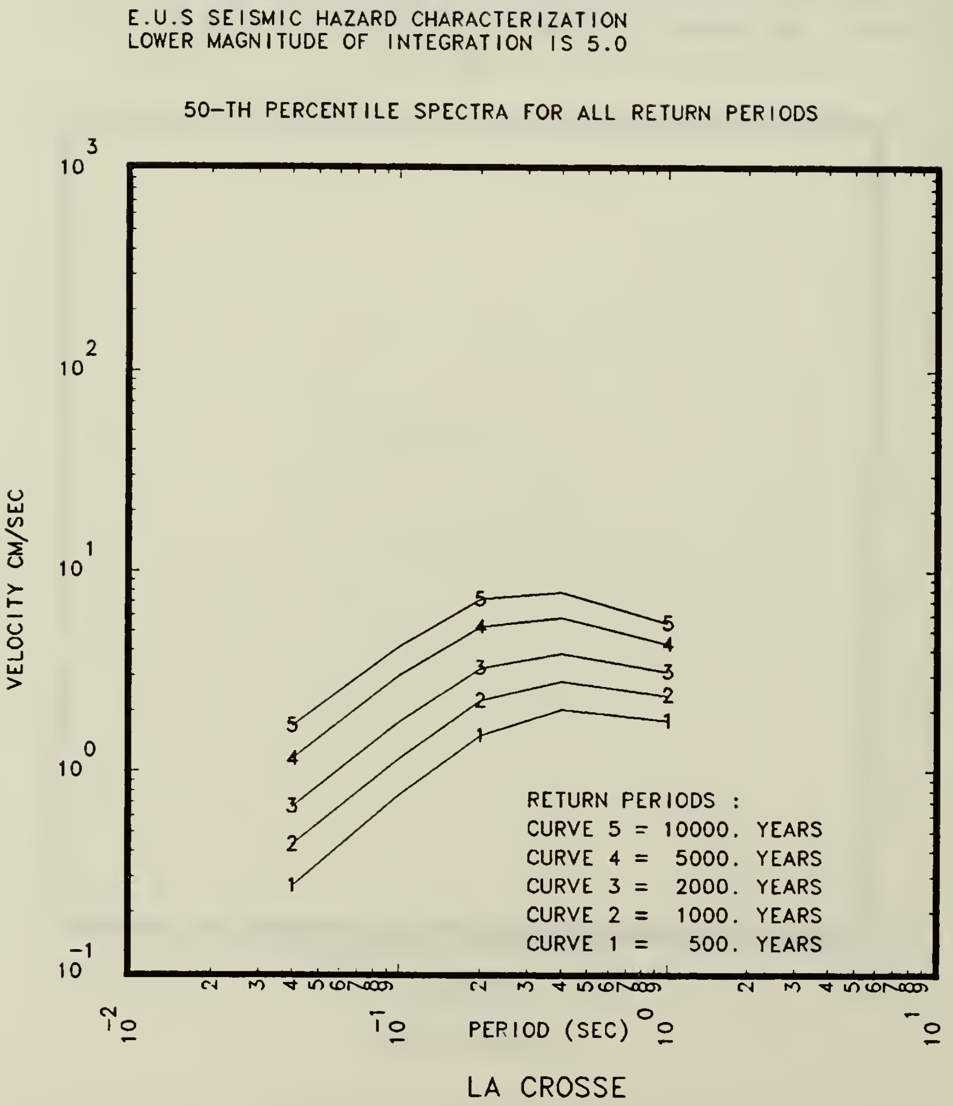


Figure 2.9.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the LaCrosse site.

2.10 MONTICELLO

Monticello was placed in the sand-1 (see table 1.4) category. It is located in region 3 (north central) and is represented by the symbol "A" on the location map (Fig. 1.1). This site is located within a low seismicity and far from the New Madrid zone as modeled by most S-Experts. Table 2.10.1 and Figs. 2.10.1 to 2.10.10 give the basic results for this site.

Figure 2.10.1 shows typical results. In addition, the AMHC is slightly higher than the 85th percentile, (see Fig. 2.3.3).

Figure 2.10.2 indicates that the diversity of opinion, as measured by the spread of the BEHC for all S-Experts, is typical. The hazard for S-Expert 12 is very low because the site is not located near a zone and S-Expert 12's CZ has an upper magnitude cutoff of 5.0; this does not contribute to the hazard.

Figure 2.10.4 shows the relative contribution of earthquakes in several ranges of magnitude. Overall, the total hazard at the Monticello site is dominated by small to very small earthquakes. This is to be expected as we see from Table 2.10 that for all the S-Experts, except S-Expert 12, that the host zone is the zone that contributes the most to the hazard. Up to approximately 0.2g, the hazard is dominated by earthquakes of magnitude below 5.0, beyond this value, the earthquakes in the lowest bin (magnitude 3.75 to 5) do not contribute significantly to the total hazard but the earthquake between magnitude 5 and 5.75 dominates. The large and very large earthquakes do not contribute significantly. Thus, for this site, adding the small earthquakes ($m < 5.0$) would increase significantly the total hazard, approximately multiply it by a factor of 3 at 0.05g and a factor of 2 and 0.25g. Beyond 0.5g the effect of including the earthquakes in the smallest bin would be small.

The spread between the G-Experts' BEHCs per S-Expert is similar to that given in Fig. 2.4.11.

TABLE 2.10.1

MOST IMPORTANT ZONES PER S-EXPERT FOR MONTICELLO

SITE SOIL CATEGORY SAND-1

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 15	ZONE ID:	ZONE 15	ZONE 11	ZONE 16	ZONE 10	ZONE 15	ZONE 10	ZONE 11	ZONE 12
		% CONT.:	74.	10.	8.	7.	100.	0.	0.	0.
2	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 13	ZONE 20	ZONE 19	COMP. ZON	ZONE 6	ZONE 13	ZONE 14
		% CONT.:	98.	1.	0.	0.	100.	0.	0.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 12	ZONE 16	ZONE 2	COMP. ZON	ZONE 2	ZONE 11	ZONE 12
		% CONT.:	99.	0.	0.	0.	100.	0.	0.	0.
4	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 6	ZONE 5	ZONE 3	COMP. ZON	ZONE 1	ZONE 3	ZONE 5
		% CONT.:	87.	6.	4.	1.	100.	0.	0.	0.
5	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 13	ZONE 14	ZONE 12	COMP. ZON	ZONE 4	ZONE 12	ZONE 13
		% CONT.:	89.	11.	0.	0.	100.	0.	0.	0.
6	ZONE 33	ZONE ID:	ZONE 33	COMP. ZON	ZONE 17	ZONE 31	ZONE 33	COMP. ZON	ZONE 9	ZONE 17
		% CONT.:	81.	17.	1.	0.	88.	12.	0.	0.
7	ZONE 3	ZONE ID:	ZONE 3	ZONE 4	ZONE 2 =	ZONE 5	ZONE 3	ZONE 4	ZONE 2 =	ZONE 17
		% CONT.:	81.	18.	1.	0.	98.	1.	1.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 32	ZONE 26A	ZONE 13	ZONE 19 =	ZONE 13	ZONE 26A	ZONE 27
		% CONT.:	100.	0.	0.	0.	100.	0.	0.	0.
11	CZ = ZON	ZONE ID:	CZ = ZONE	ZONE 18	ZONE 17	ZONE 10	CZ = ZONE	ZONE 18	ZONE 9	ZONE 10
		% CONT.:	95.	4.	1.	0.	100.	0.	0.	0.
12	ZONE 4 =	ZONE ID:	ZONE 5	ZONE 13	ZONE 40	ZONE 7	ZONE 5	ZONE 6	ZONE 7	ZONE 13
		% CONT.:	65.	23.	7.	2.	0.	0.	0.	0.
13	CZ 15	ZONE ID:	CZ 15	ZONE 6	ZONE 18	ZONE 3	CZ 15	ZONE 3	ZONE 6	ZONE 18
		% CONT.:	100.	0.	0.	0.	100.	0.	0.	0.

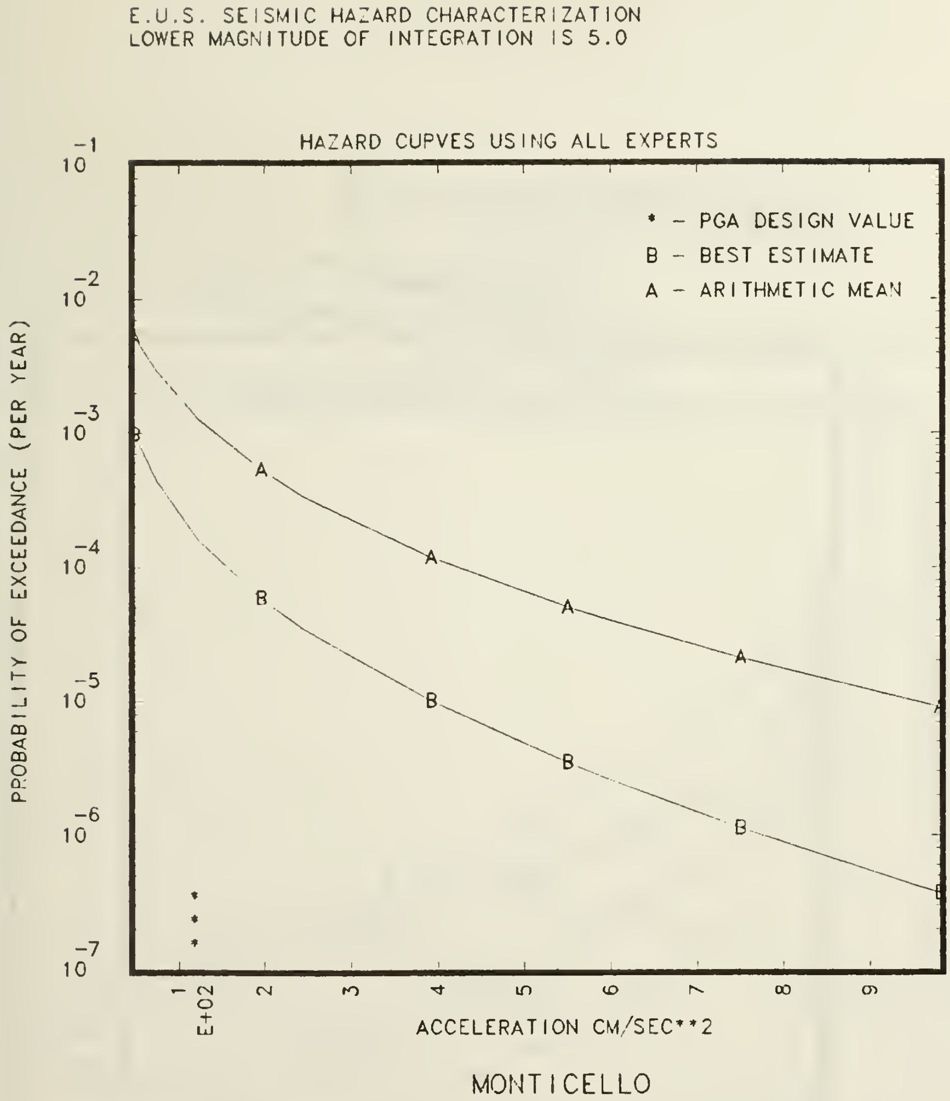


Figure 2.10.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Monticello site.

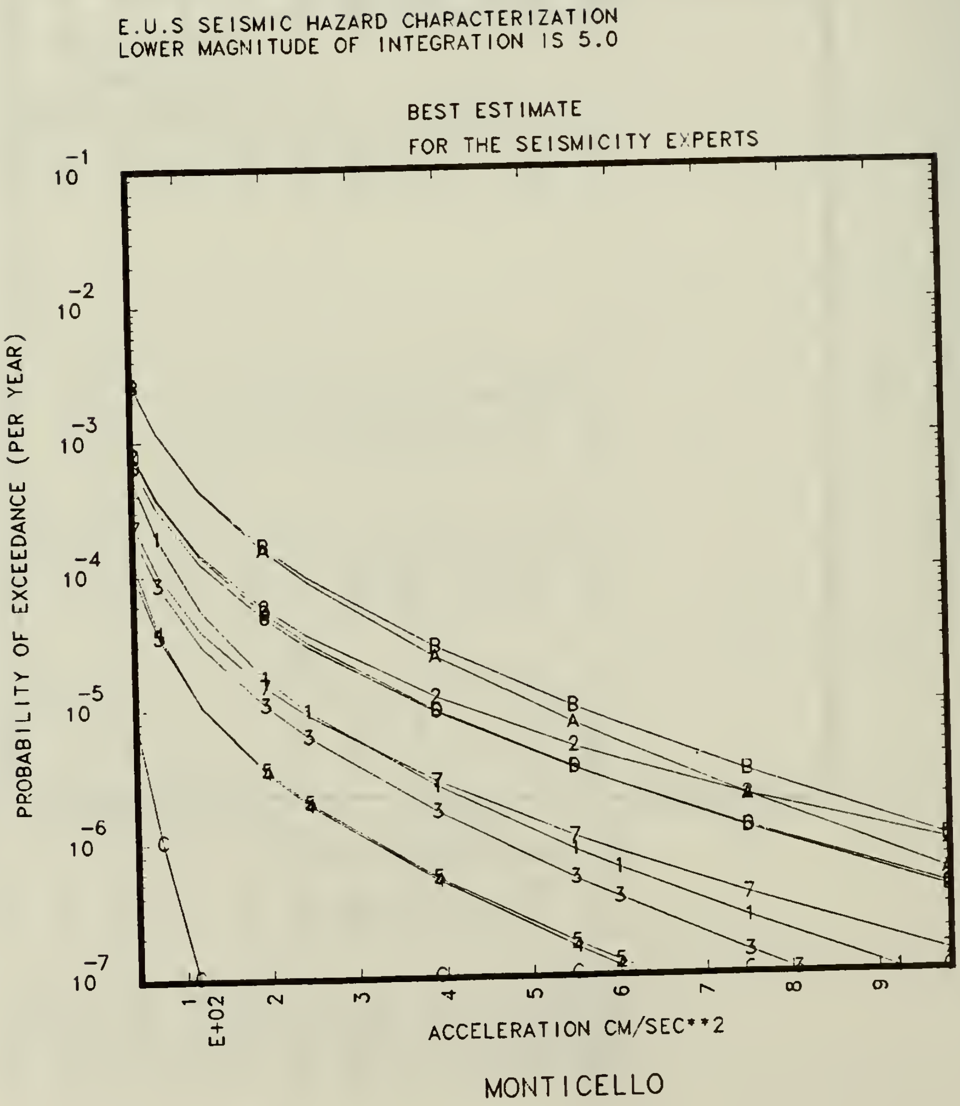


Figure 2.10.2 BEHCs per S-Expert combined over all G-Experts for the Monticello site. Plot symbols given in Table 2.0.

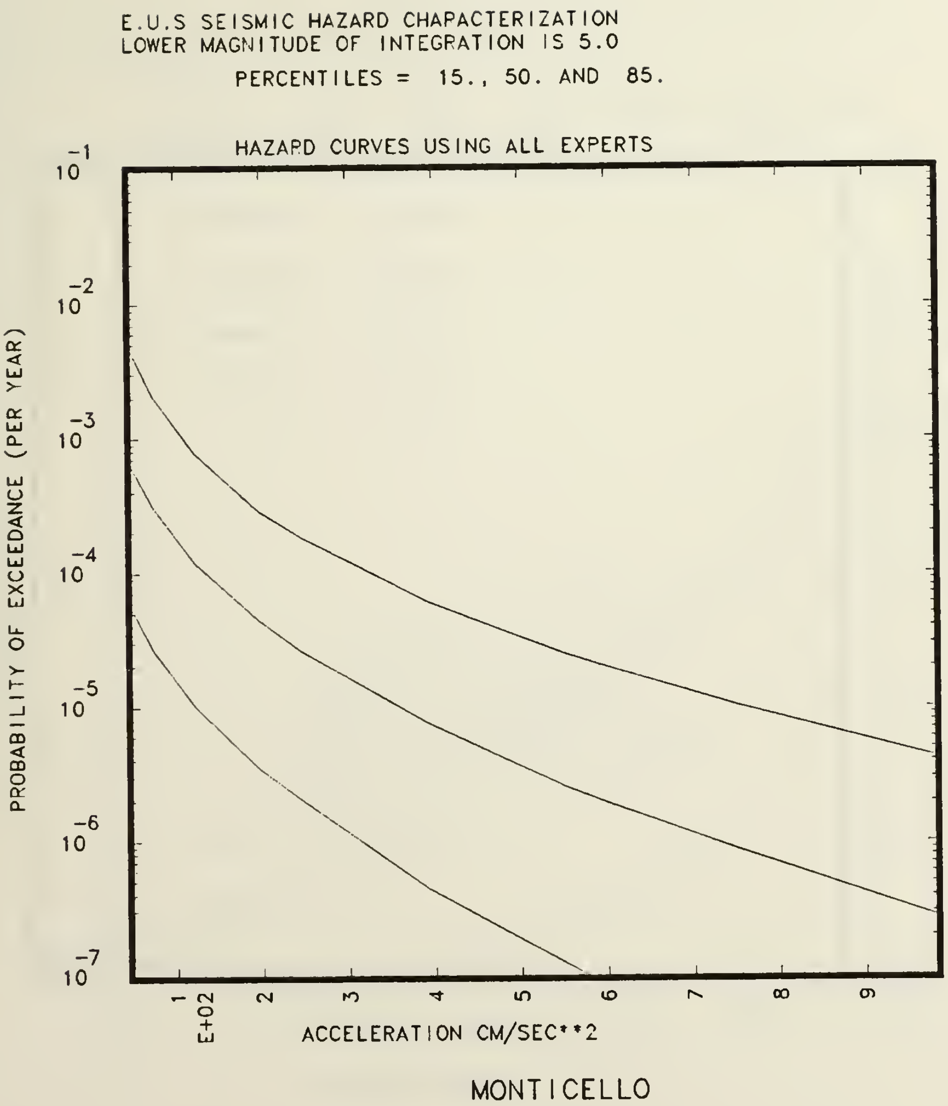


Figure 2.10.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Monticello site.

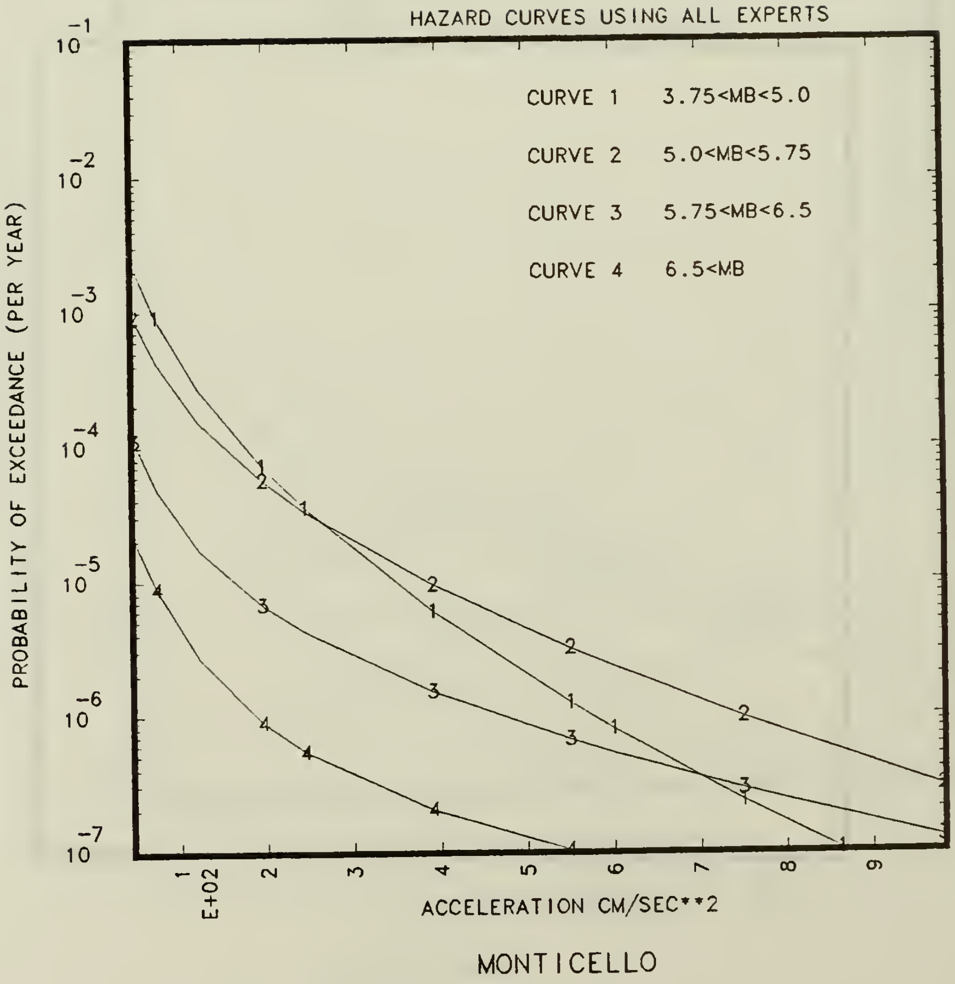


Figure 2.10.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Monticello site.

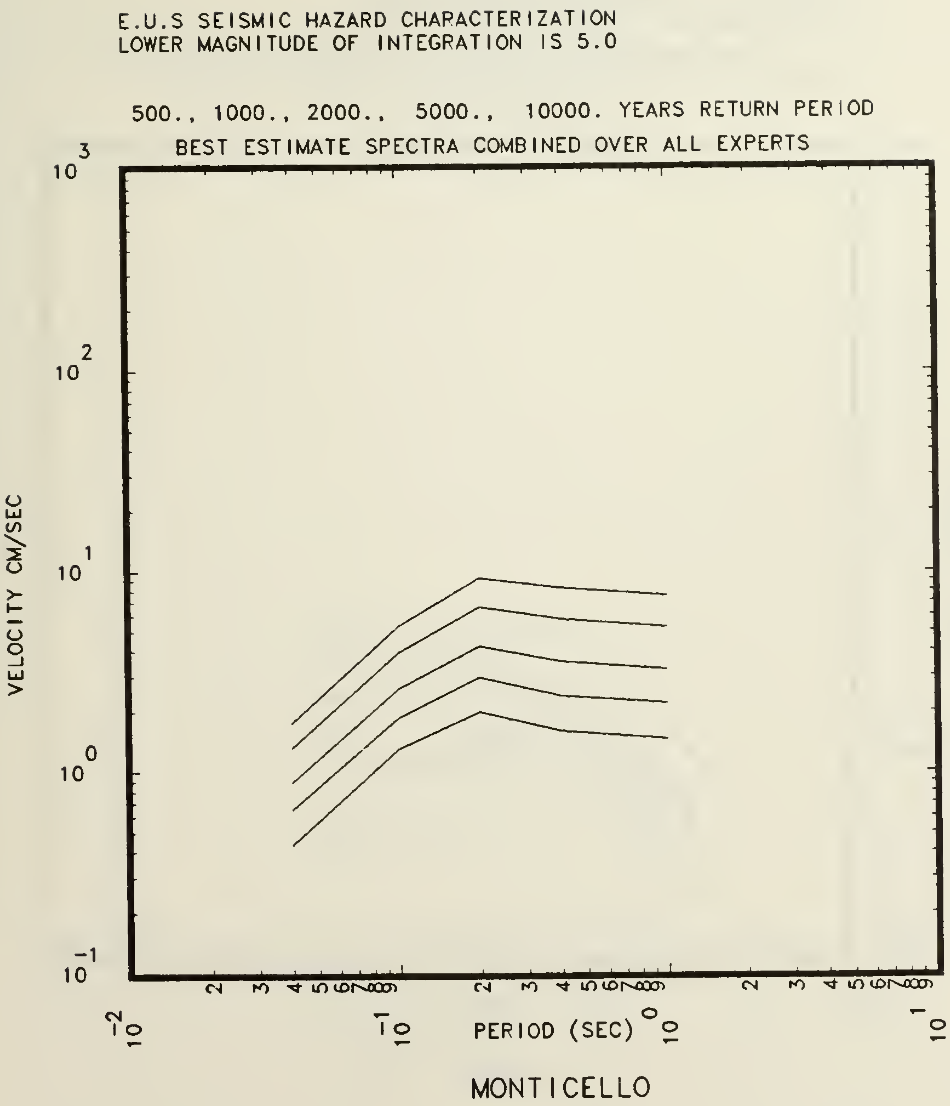


Figure 2.10.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Monticello site.

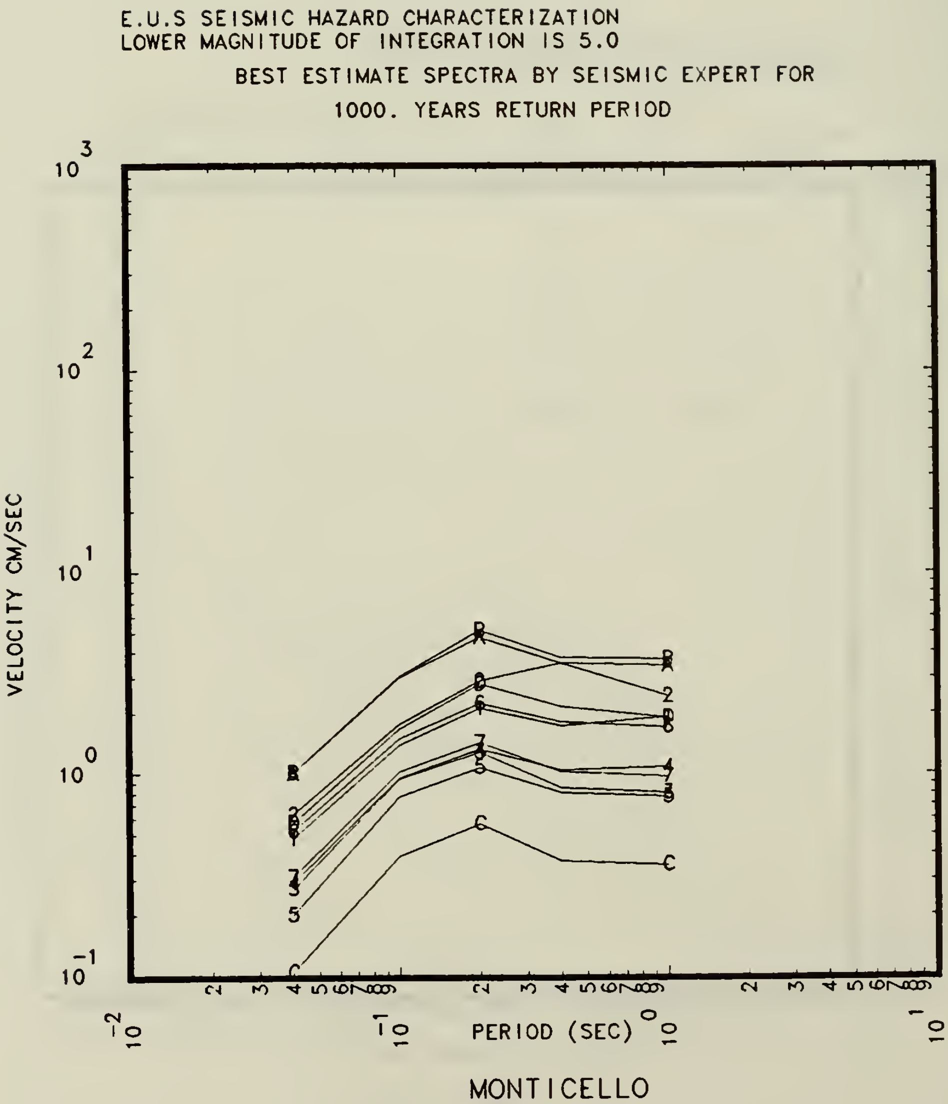


Figure 2.10.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Monticello site. Plot symbols are given in Table 2.0.

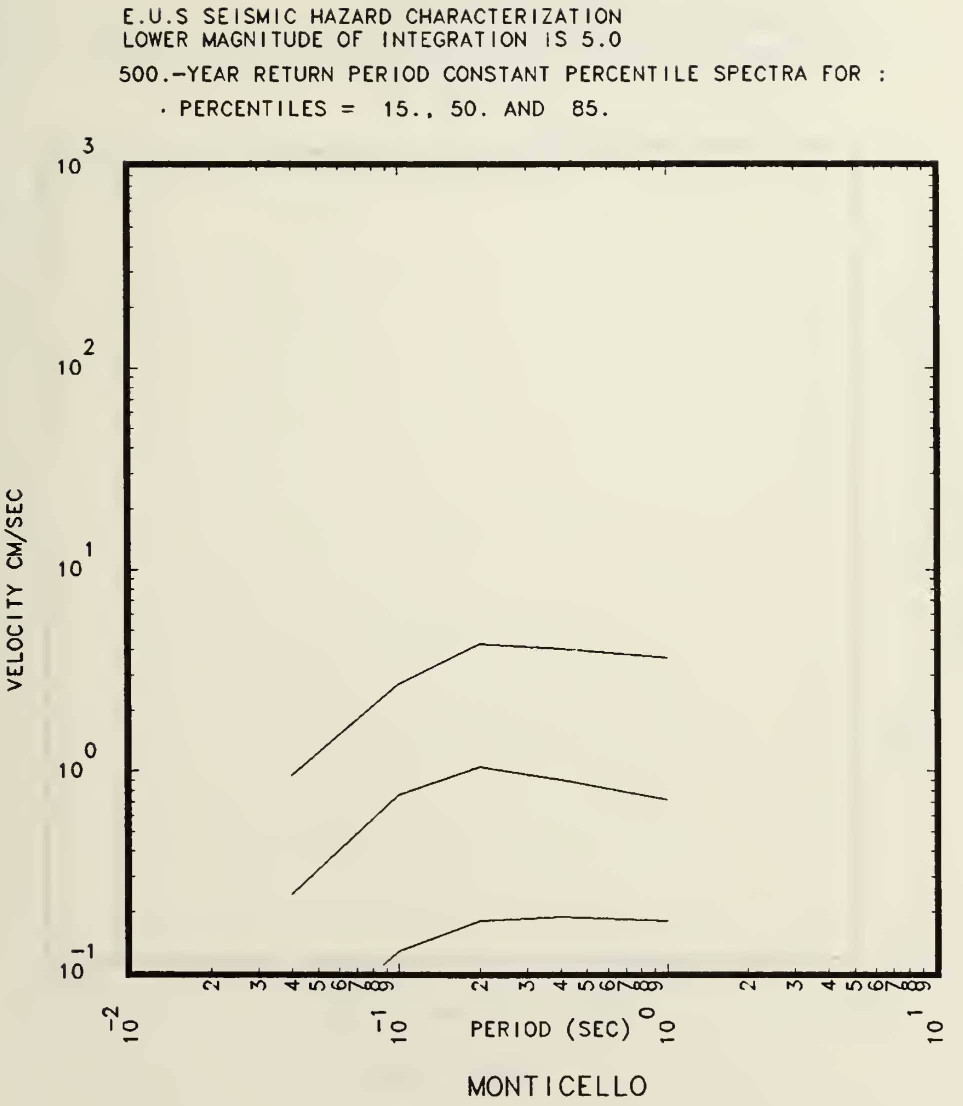


Figure 2.10.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Monticello site.

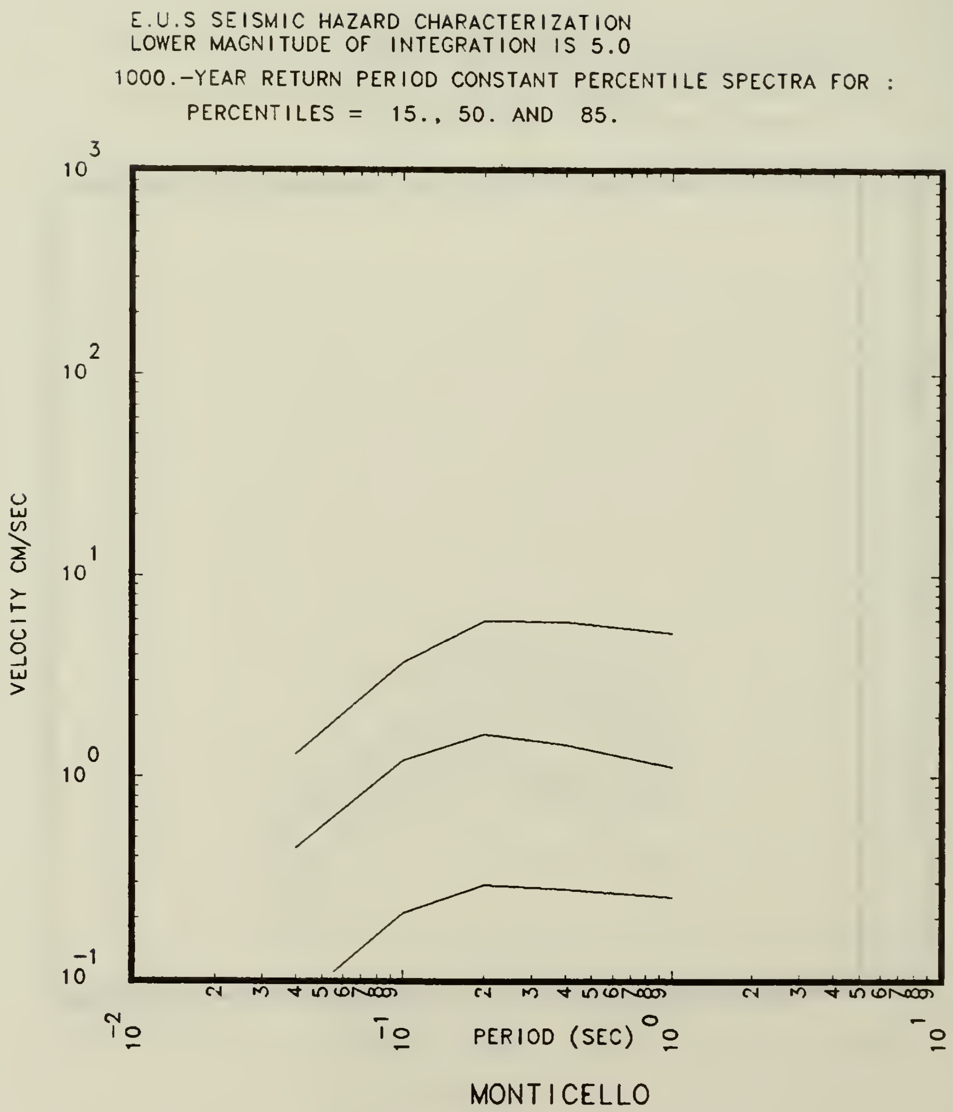
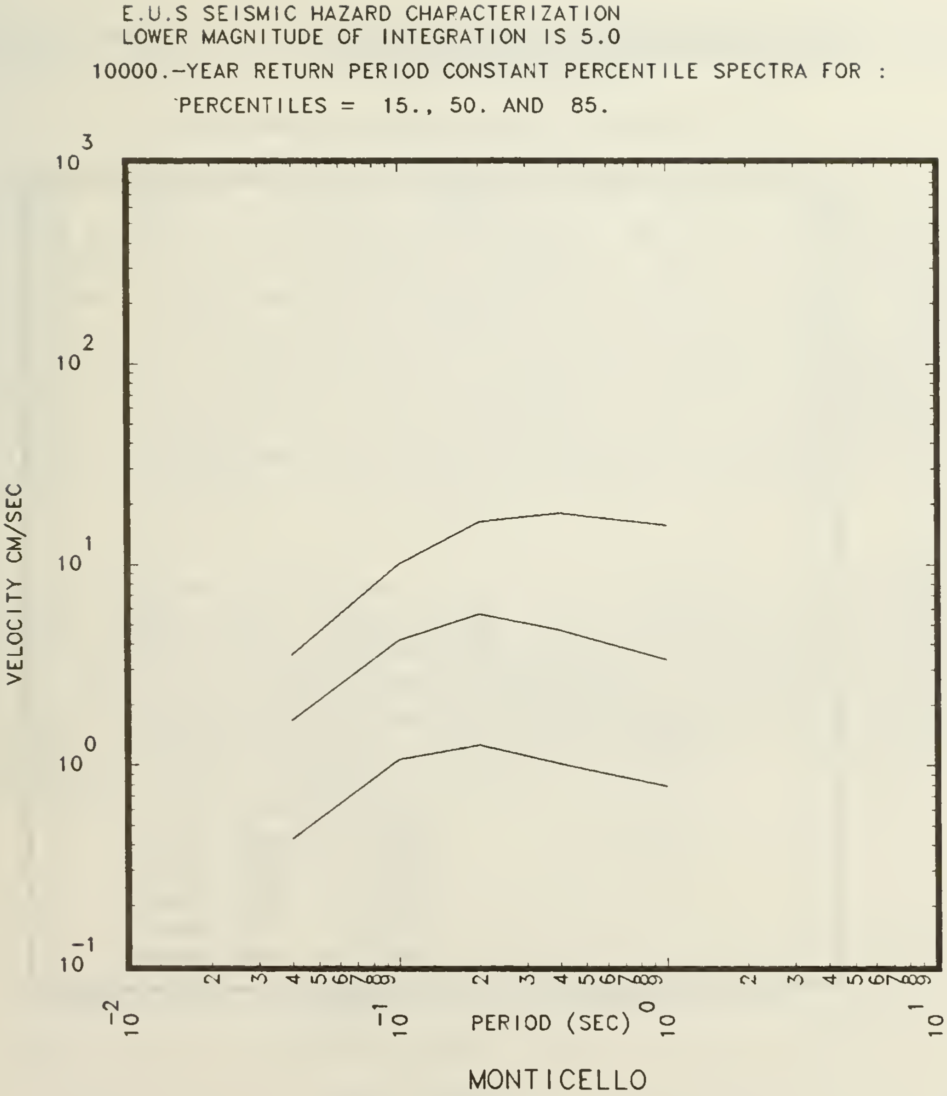


Figure 2.10.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Monticello site.



igure 2.10.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Monticello site.

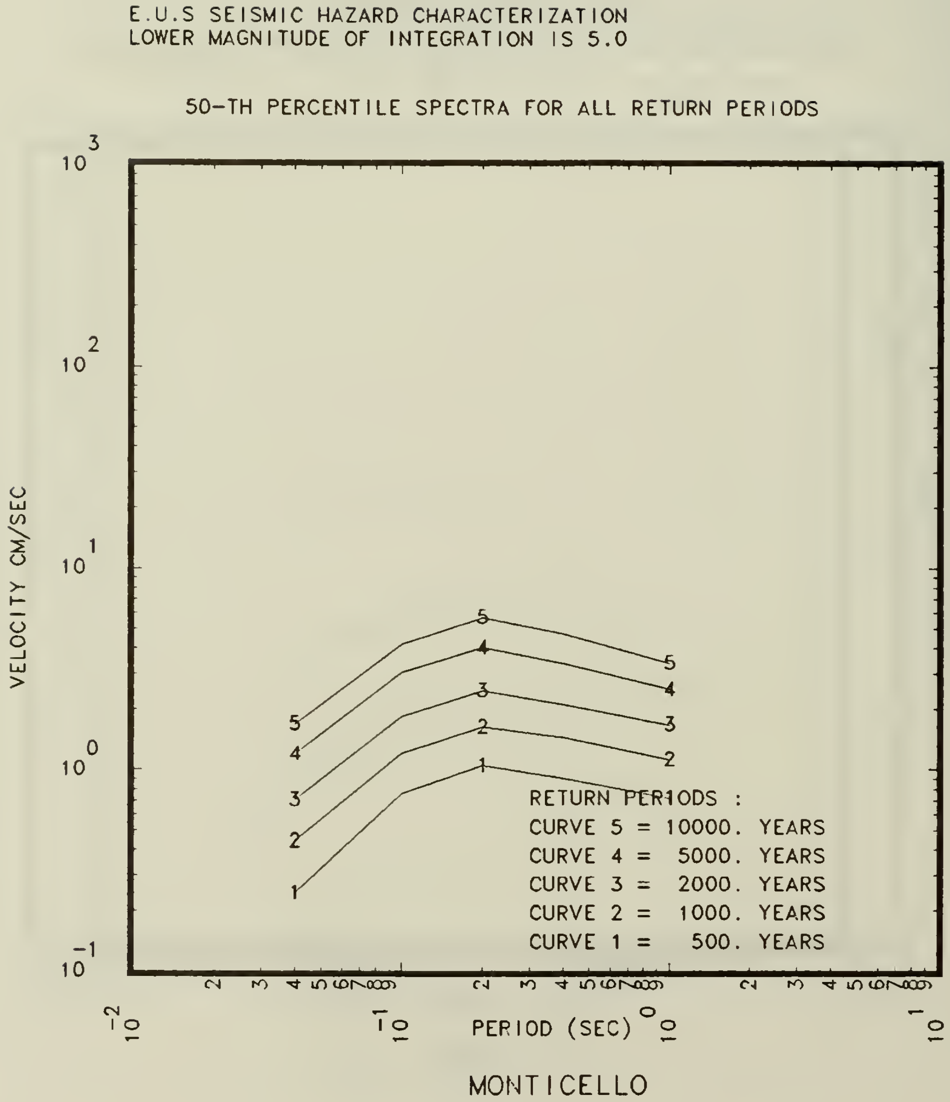


Figure 2.10.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Monticello site.

2.11 PRAIRIE ISLAND

Prairie Island was placed in the sand-2 (see table 1.4) category. It is located in region 3 (north central) and is represented by the symbol "B" on the location map (Fig. 1.1). This site is located within a zone with relatively low seismicity and large distance from the zones representing the New Madrid area as modeled by most S-Experts. Table 2.11.1 and Figs. 2.11.1 to 2.11.10 give the basic results for this site.

Figure 2.11.1 shows typical results. In addition, the AMHC is slightly higher than the 85th percentile, (see Fig. 2.11.3).

Figure 2.11.2 indicates that the diversity of opinion, as measured by the spread of the BEHC for all S-Experts, is typical.

Figure 2.11.4 shows the relative contribution of earthquakes in several ranges of magnitude. Overall, the total hazard at the Prairie Island site is dominated by small to very small earthquakes. Up to approximately 0.2g, the hazard is dominated by earthquakes of magnitude below 5.0, beyond this value, the earthquakes in the lowest bin (magnitude 3.75 to 5) do not contribute significantly to the total hazard but the earthquakes between magnitude 5.0 and 5.75 dominate. The large and very large earthquakes do not contribute significantly. Thus, for this site, adding the small earthquakes ($m_b < 5.0$) would increase significantly the total hazard approximately multiply it by a factor of 3.0 at 0.05g and a factor of 2 at 0.25g. Beyond 0.5g the effect of including the earthquakes in the smallest bin would be small.

The discussions given in Sections 2.4 and 2.8 relative to the spread between the G-Experts' BEHCs per S-Expert holds. The Prairie Island site is closer to the New Madrid region than the Monticello site. Thus, we see from Table 2.11.1 that for a few S-Experts the New Madrid region contributes to the hazard. For these S-Experts, the spread between G-Expert 5's BEHC and the other G-Experts' BEHCs is slightly larger than shown in Fig. 2.4.11, but much less than shown in Fig. 2.4.12.

TABLE 2.11.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR PRAIRIE ISLAND

SITE SOIL CATEGORY SAND-2

S-XPT NUM.	HOST ZONE		Low PGA (0.125G)				High PGA (0.60G)			
			ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 15	ZONE ID:	ZONE 15	ZONE 11	ZONE 10	ZONE 9	ZONE 15	ZONE 9	ZONE 11	ZONE 10
		% CONT.:	60.	16.	14.	8.	96.	3.	0.	0.
2	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 18	ZONE 20	ZONE 13	COMP. ZON	ZONE 18	ZONE 6	ZONE 13
		% CONT.:	73.	26.	1.	0.	94.	6.	0.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 13	ZONE 12	ZONE 16	COMP. ZON	ZONE 13	ZONE 2	ZONE 11
		% CONT.:	97.	2.	1.	0.	100.	0.	0.	0.
4	COMP. ZO	ZONE ID:	ZONE 4	COMP. ZON	ZONE 6	ZONE 13	COMP. ZON	ZONE 4	ZONE 13	ZONE 6
		% CONT.:	34.	29.	16.	13.	81.	11.	8.	0.
5	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 15	ZONE 13	ZONE 14	COMP. ZON	ZONE 15	ZONE 4	ZONE 12
		% CONT.:	59.	29.	11.	1.	88.	12.	0.	0.
6	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 17	ZONE 33	ZONE 18	COMP. ZON	ZONE 17	ZONE 33	ZONE 18
		% CONT.:	81.	10.	6.	1.	100.	0.	0.	0.
7	ZONE 3	ZONE ID:	ZONE 3	ZONE 6	ZONE 4	ZONE 5	ZONE 3	ZONE 6	ZONE 2 =	ZONE 4
		% CONT.:	65.	32.	1.	1.	92.	6.	2.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 32	ZONE 12A	ZONE 26A	ZONE 19 =	ZONE 12A	ZONE 13	ZONE 26A
		% CONT.:	100.	0.	0.	0.	100.	0.	0.	0.
11	CZ = ZON	ZONE ID:	CZ = ZONE	ZONE 10	ZONE 18	ZONE 11	CZ = ZONE	ZONE 9	ZONE 10	ZONE 11
		% CONT.:	98.	1.	0.	0.	100.	0.	0.	0.
12	ZONE 4 =	ZONE ID:	ZONE 15	ZONE 14	ZONE 13	ZONE 31A	ZONE 15	ZONE 5	ZONE 6	ZONE 7
		% CONT.:	69.	13.	11.	5.	100.	0.	0.	0.
13	CZ 15	ZONE ID:	CZ 15	ZONE 6	ZONE 18	ZONE 3	CZ 15	ZONE 3	ZONE 4	ZONE 6
		% CONT.:	100.	0.	0.	0.	100.	0.	0.	0.

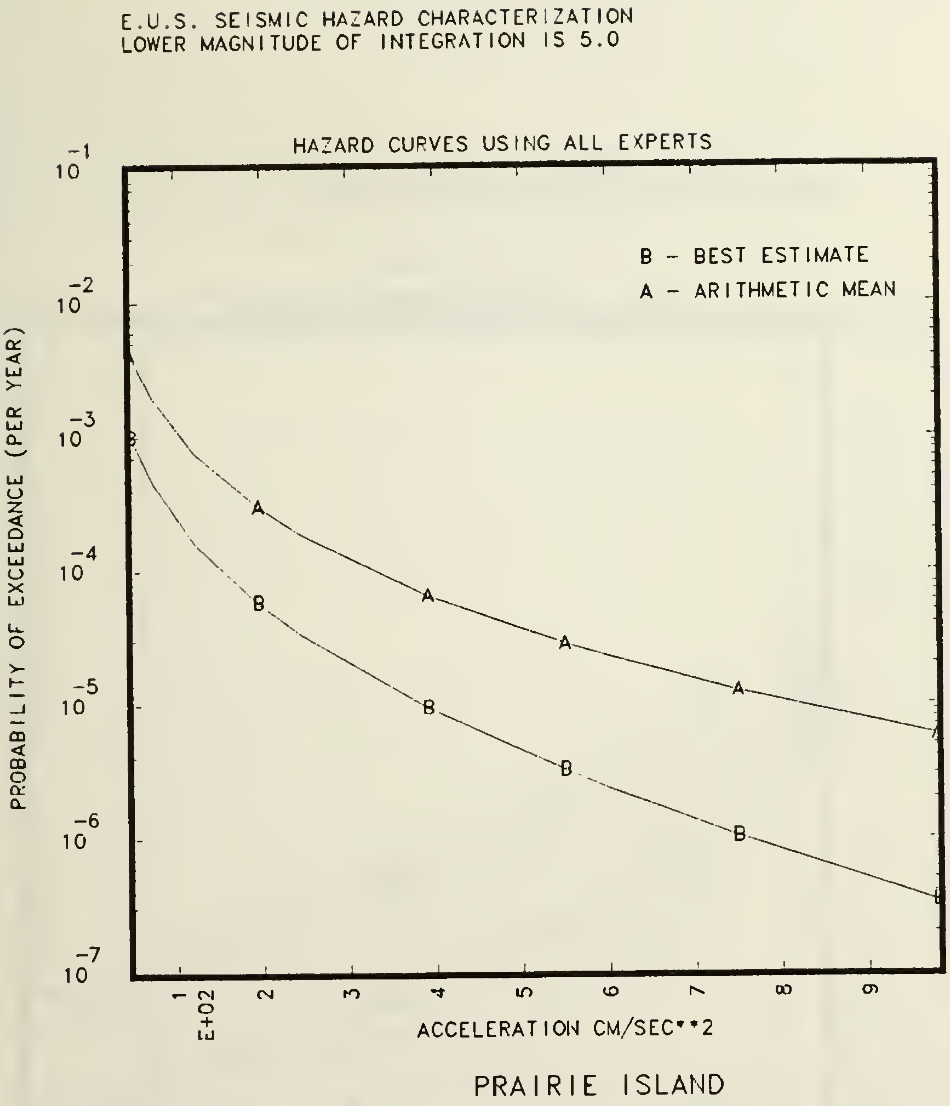


Figure 2.11.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Prairie Island site.

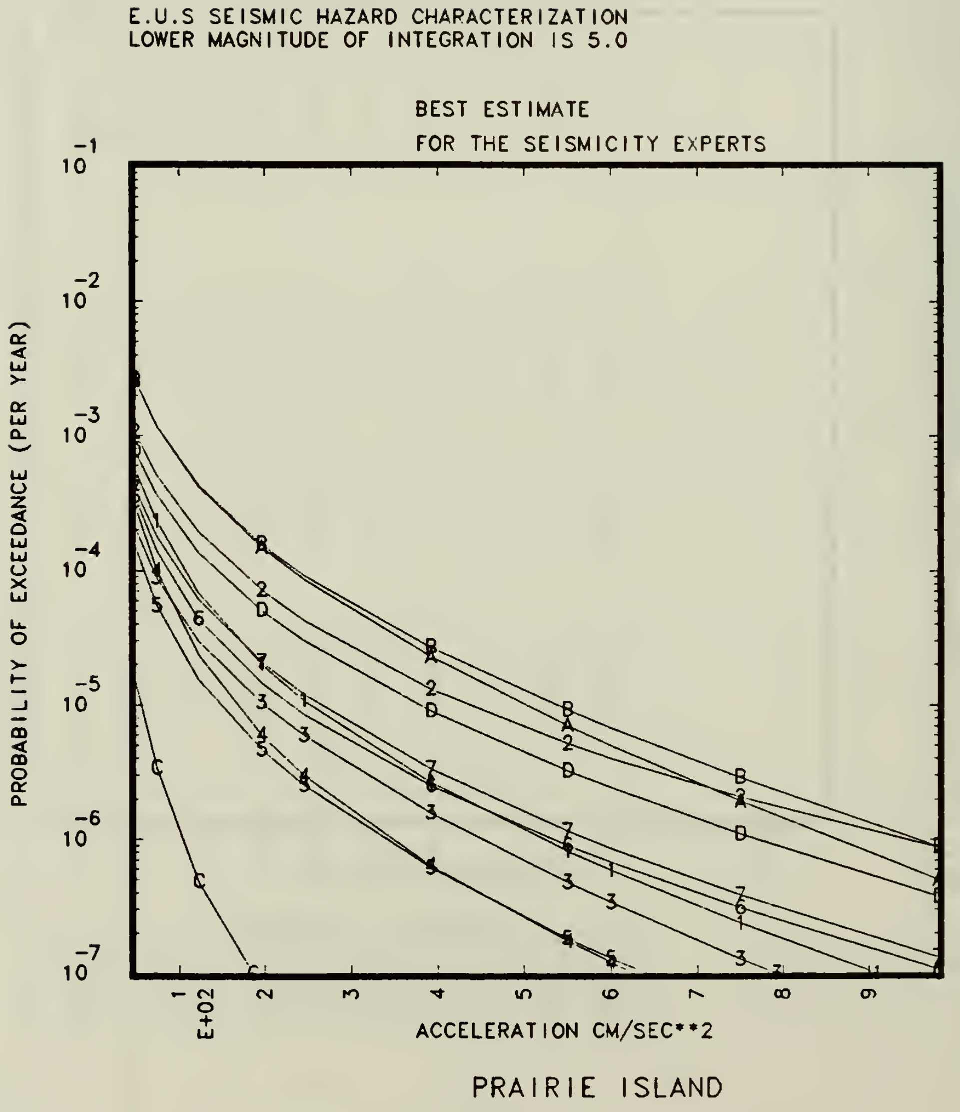


Figure 2.11.2 BEHCs per S-Expert combined over all G-Experts for the Prairie Island site. Plot symbols given in Table 2.0.

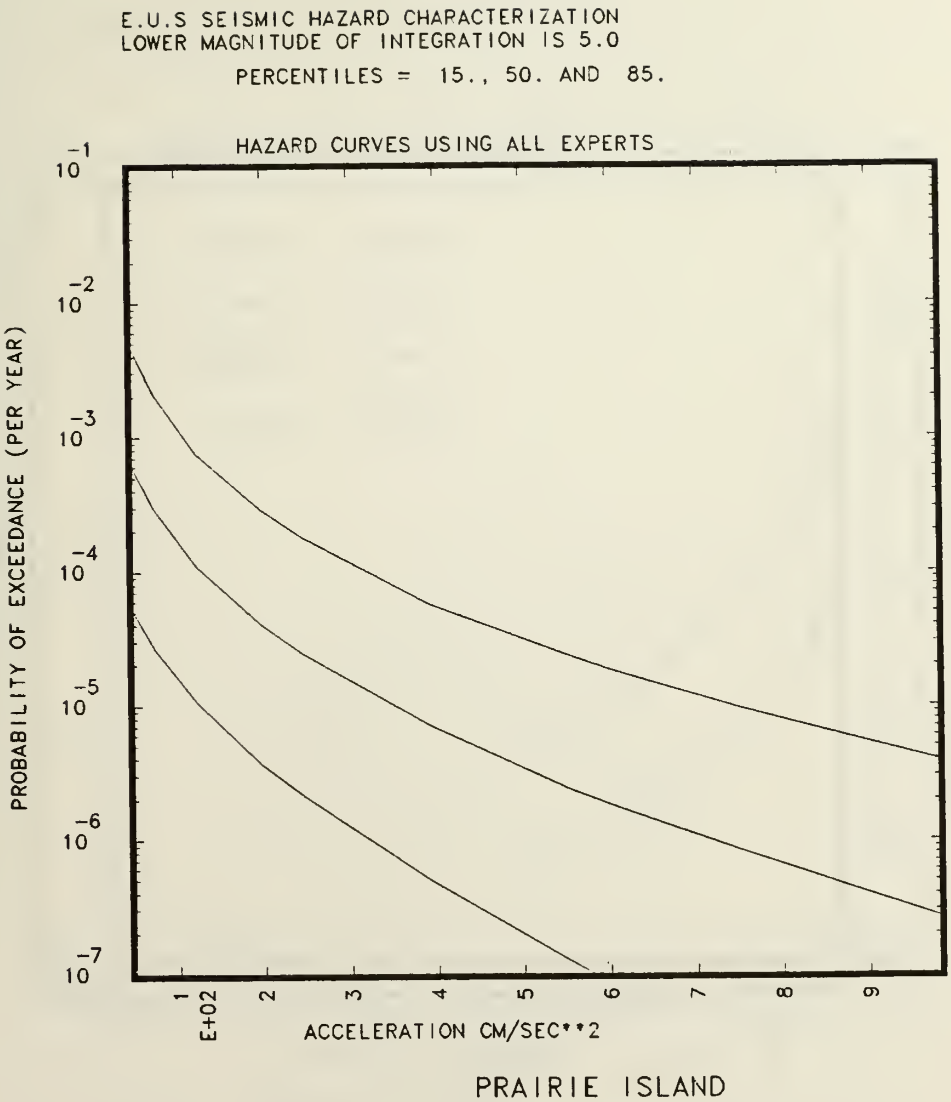


Figure 2.11.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Prairie Island site.

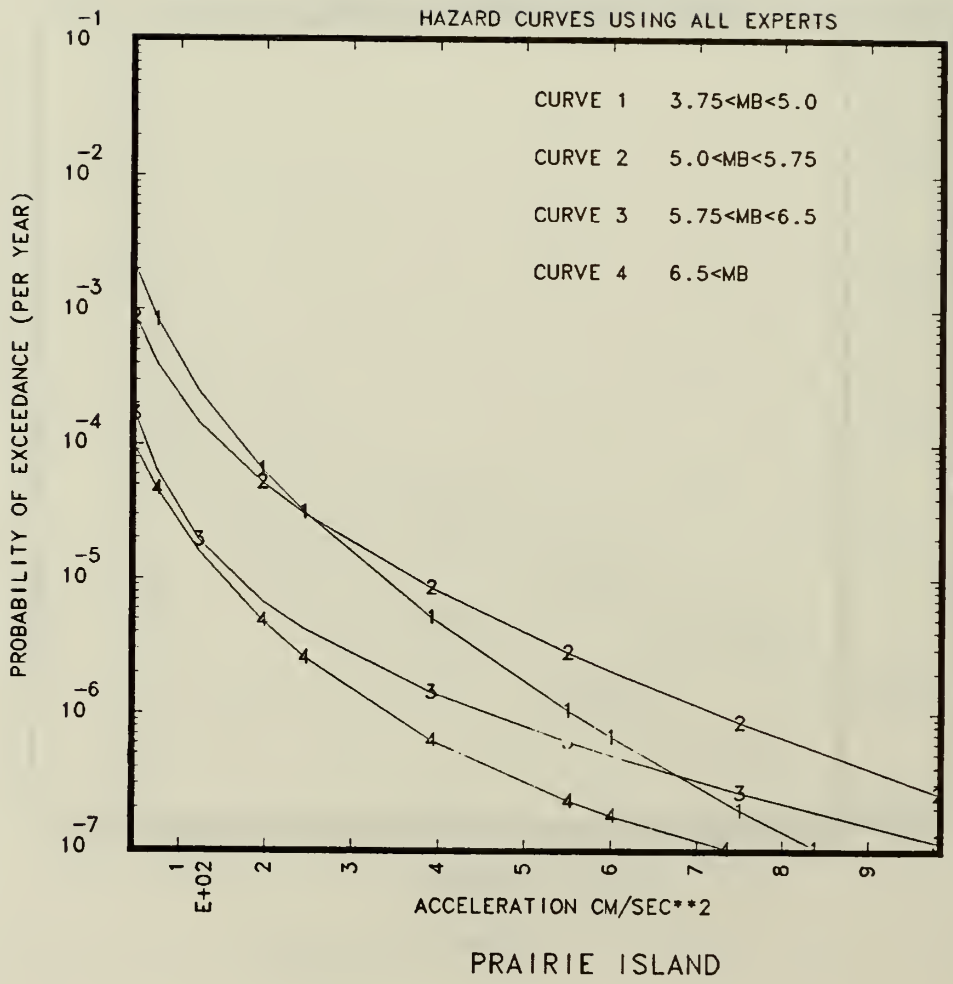


Figure 2.11.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Prairie Island site.

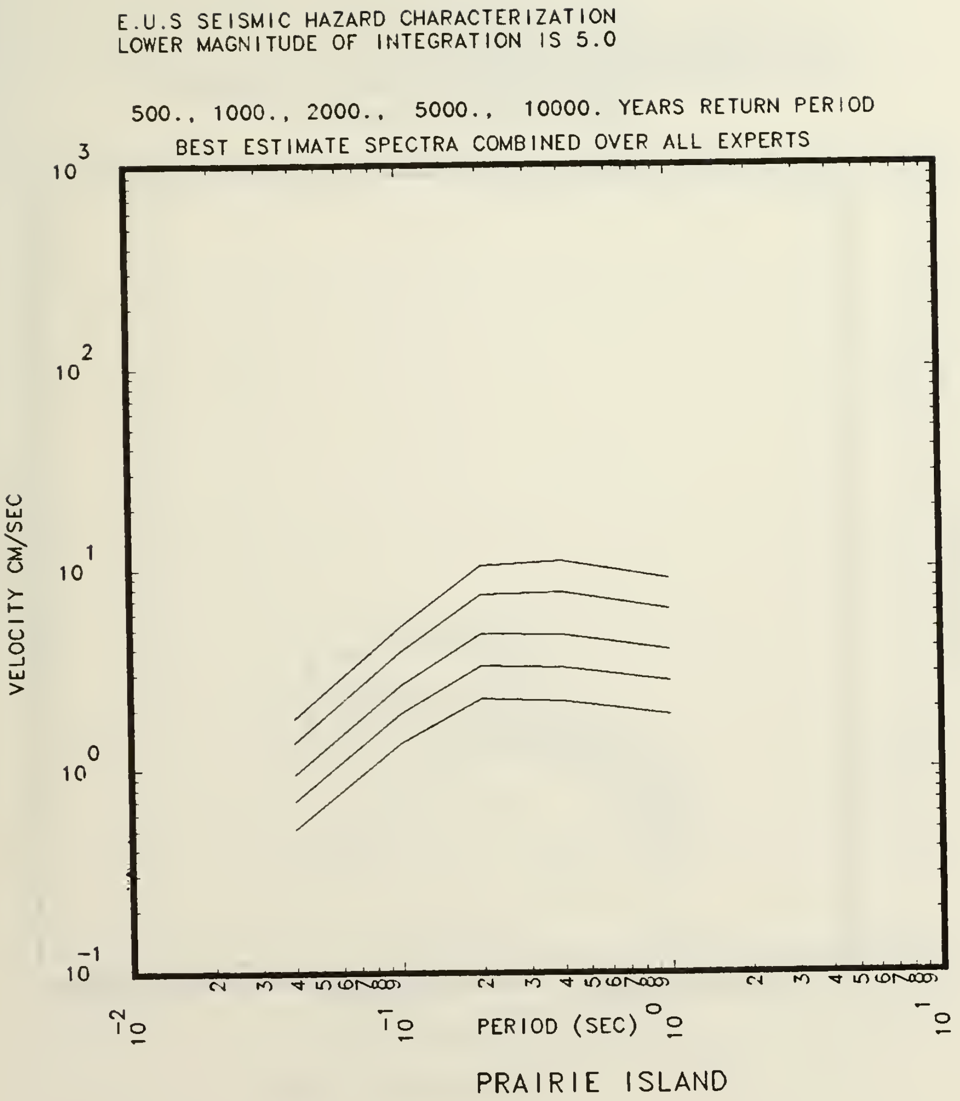


Figure 2.11.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Prairie Island site.

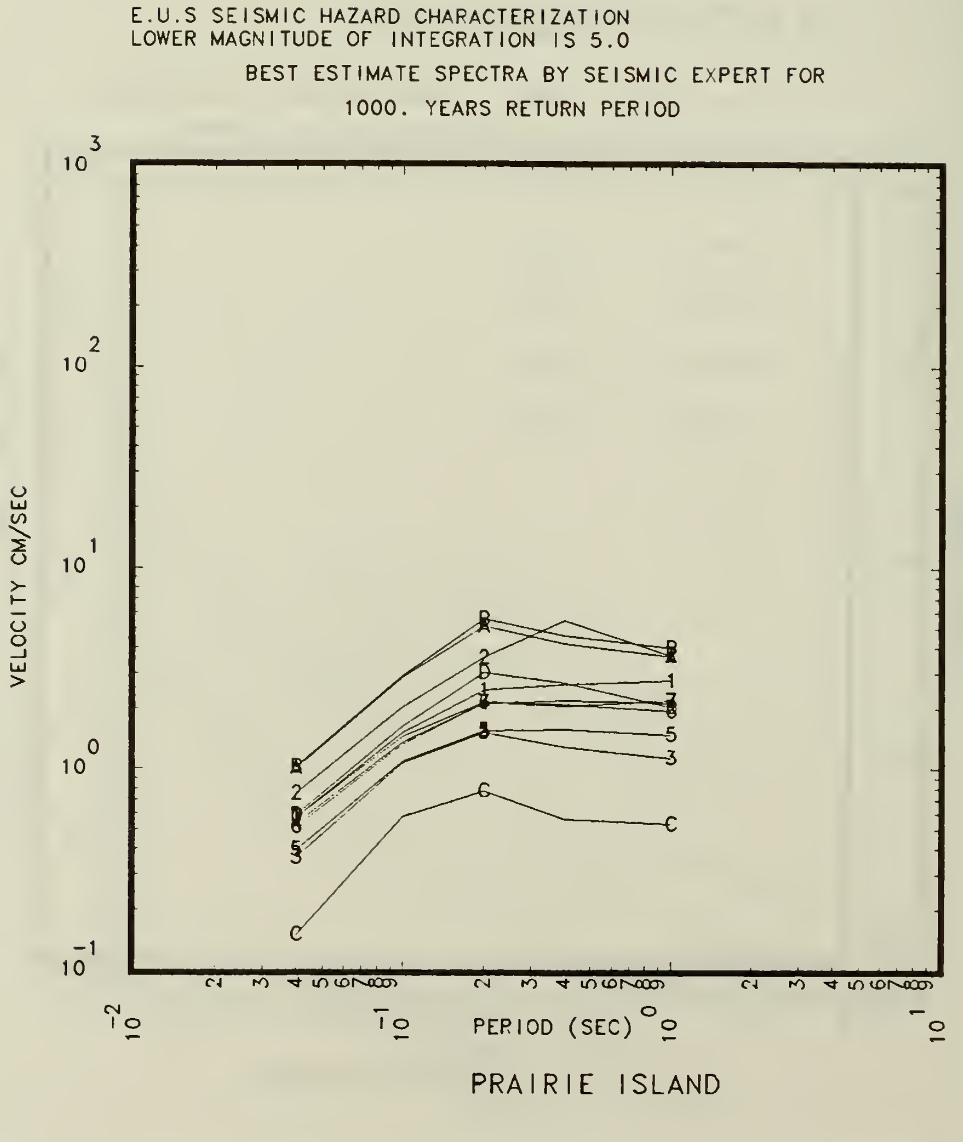


Figure 2.11.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Prairie Island site. Plot symbols are given in Table 2.0.

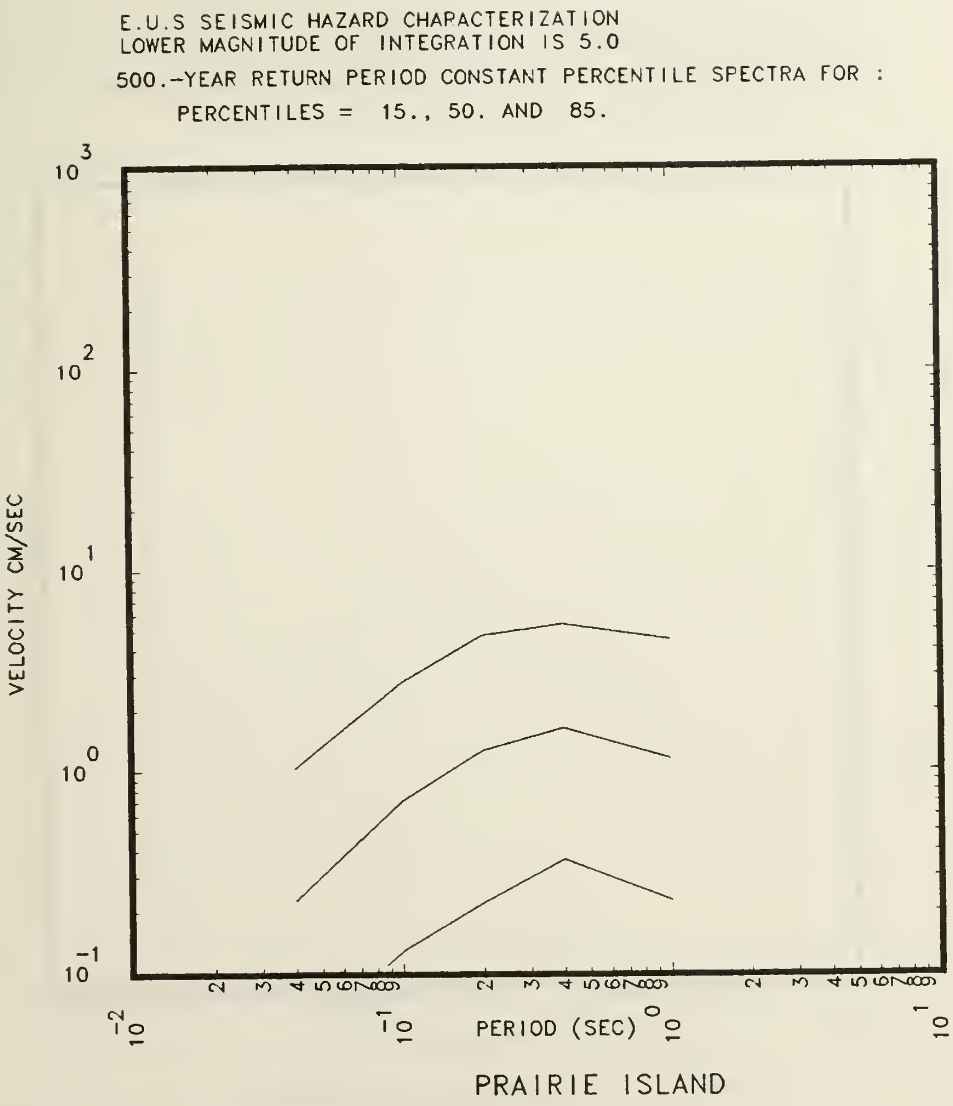


Figure 2.11.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Prairie Island site.

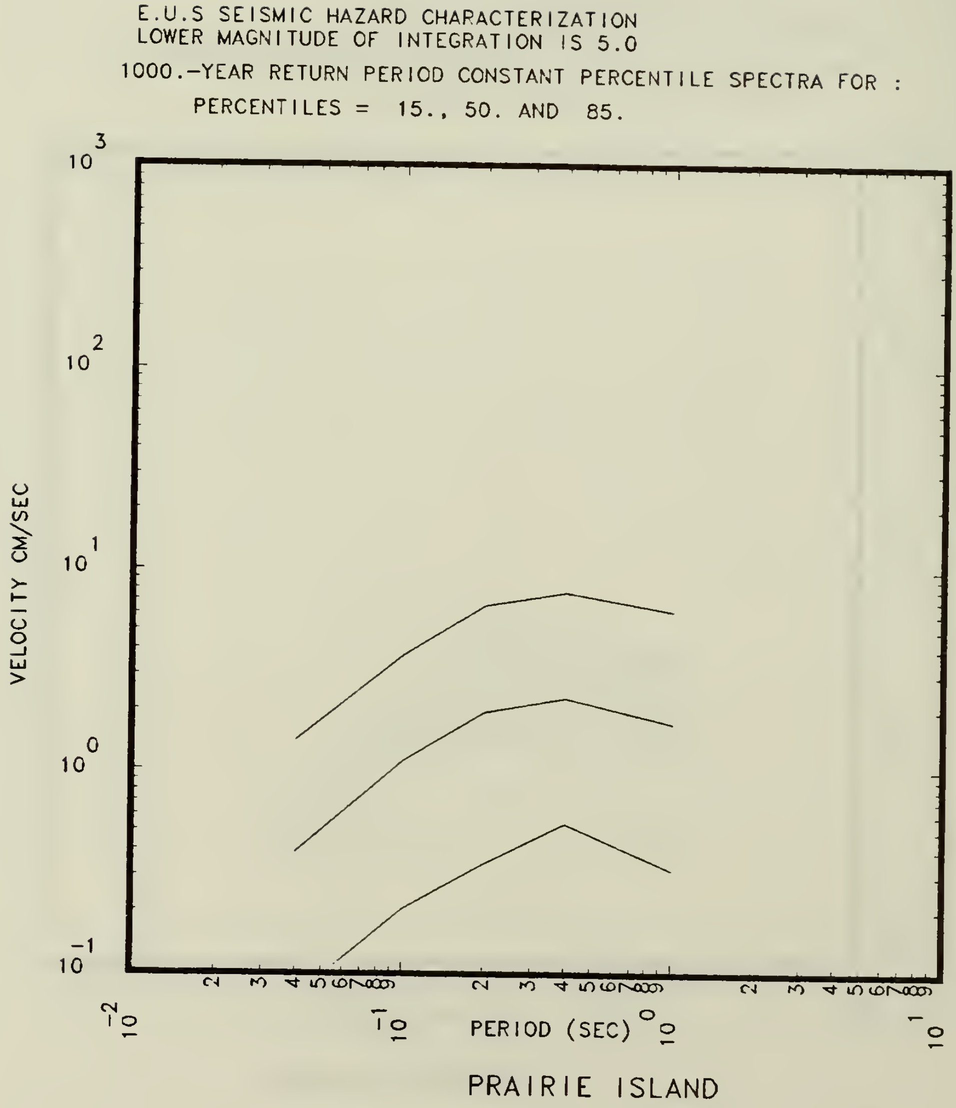


Figure 2.11.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Prairie Island site.

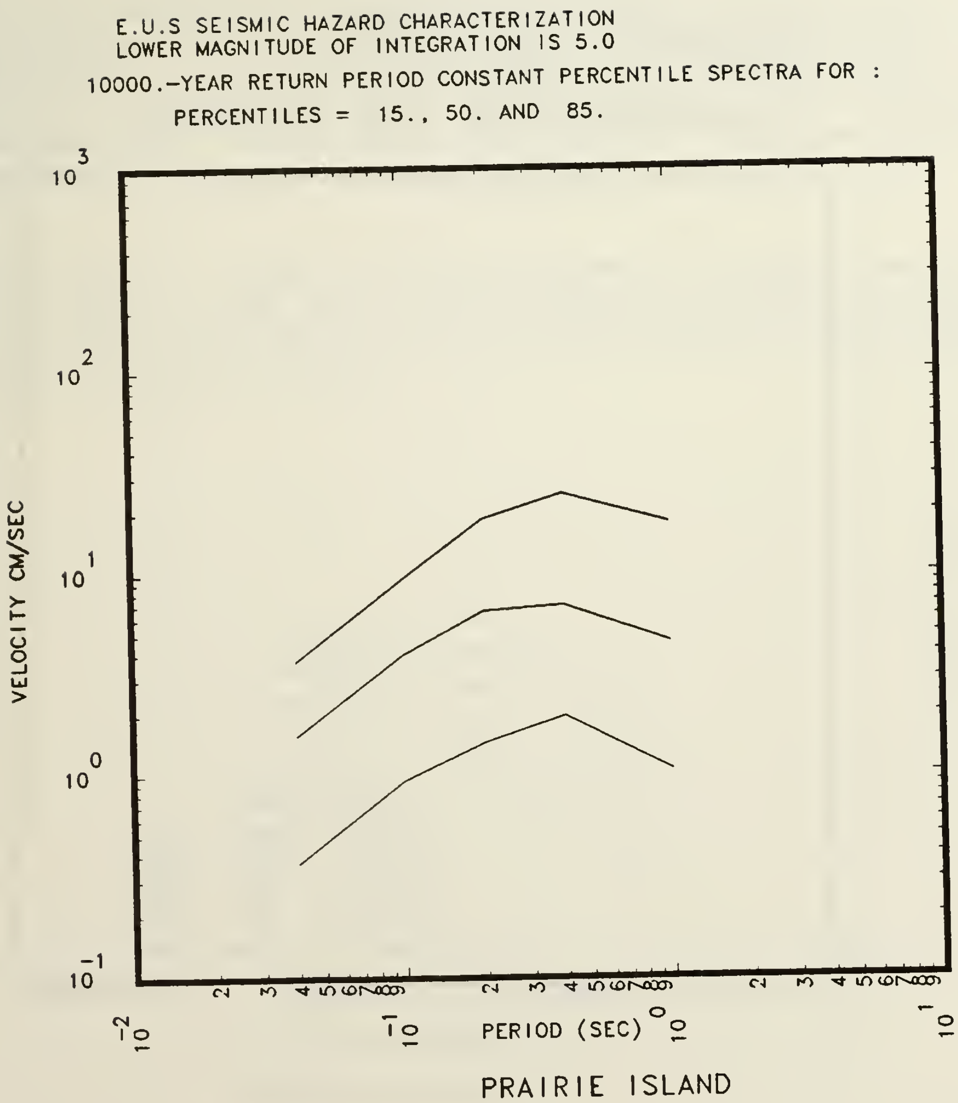


Figure 2.11.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Prairie Island site.

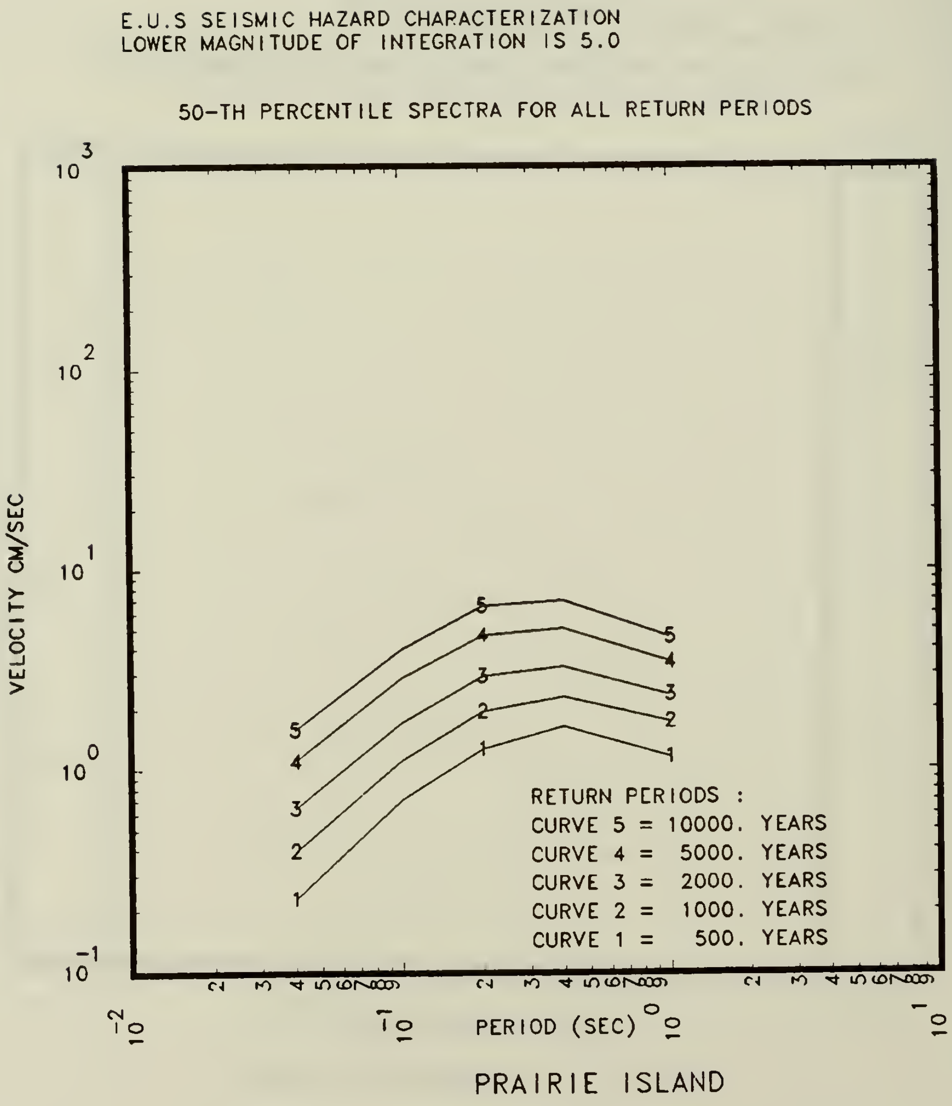


Figure 2.11.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Prairie Island site.

2.12 RIVER BEND

River Bend is a deep soil site and is represented by the symbol "C" in Fig. 1.1. Table 2.12.1 and Figs. 2.12.1 to 2.12.10 give the basic results for the River Bend site.

Table 2.12.1 shows that the dominant contribution is from either the host zone or some distant zone with high upper magnitude cutoff. Thus a discrimination of the hazard by distance bins would show no clear dominance.

Similarly, discrimination of earthquake contribution by magnitude bins also does not show clear dominance of earthquakes in any magnitude range. The small earthquakes (3.75 to 5.00) would dominate for PGA smaller than 0.15g. Thus including the small earthquakes in the range up to PGA = 0.15g would modify the BEHC significantly, and on the contrary it would not affect the BEHC above 0.2g.

Because River Bend is a deep soil site, G-Expert 5's GM model does not dominate as it does in the case of rock sites (See Sections 2.1 and 2.4). The discussions given in Sections 2.4 and 2.8 holds relative to the spread between the G-Experts' BEHCs per S-Expert.

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TABLE 2.12.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR RIVER BEND

SITE SOIL CATEGORY DEEP-SOIL

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 1	ZONE ID:	ZONE 1	ZONE 9	ZONE 10	ZONE 5	ZONE 1	ZONE 9	ZONE 5	ZONE 3
		% CONT.:	64.	30.	3.	2.	89.	11.	0.	0.
2	COMP. ZO	ZONE ID:	ZONE 18	COMP. ZON	ZONE 27	ZONE 20	ZONE 18	COMP. ZON	ZONE 1	ZONE 2
		% CONT.:	82.	18.	0.	0.	59.	41.	0.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 13	ZONE 10	ZONE 8A	COMP. ZON	ZONE 13	ZONE 10	ZONE 8A
		% CONT.:	68.	13.	12.	3.	97.	2.	1.	1.
4	ZONE 25	ZONE ID:	ZONE 4	ZONE 25	ZONE 3	ZONE 8	ZONE 4	ZONE 25	COMP. ZON	ZONE 1
		% CONT.:	96.	3.	0.	0.	95.	5.	0.	0.
5	COMP. ZO	ZONE ID:	ZONE 15	ZONE 11	COMP. ZON	ZONE 14	ZONE 15	ZONE 11	COMP. ZON	ZONE 8
		% CONT.:	65.	30.	5.	0.	87.	7.	6.	0.
6	ZONE 21	ZONE ID:	ZONE 21	ZONE 18	ZONE 17	ZONE 20	ZONE 21	COMP. ZON	ZONE 18	ZONE 20
		% CONT.:	80.	9.	6.	2.	98.	1.	1.	0.
7	ZONE 2 =	ZONE ID:	ZONE 6	ZONE 2 =	ZONE 1	ZONE 5	ZONE 6	ZONE 2 =	ZONE 1	ZONE 5
		% CONT.:	88.	10.	2.	1.	76.	24.	1.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 12A	ZONE 29	ZONE 28	ZONE 19 =	ZONE 4B	ZONE 12A	ZONE 13
		% CONT.:	97.	3.	0.	0.	100.	0.	0.	0.
11	ZONE 14	ZONE ID:	ZONE 14	ZONE 11	ZONE 8	ZONE 15	ZONE 14	CZ = ZONE	ZONE 11	ZONE 8
		% CONT.:	59.	25.	6.	3.	82.	12.	6.	1.
12	ZONE 10	ZONE ID:	ZONE 15	ZONE 11	ZONE 3	ZONE 14	ZONE 15	ZONE 3	ZONE 11	ZONE 6
		% CONT.:	50.	25.	13.	9.	95.	5.	0.	0.
13	CZ 16	ZONE ID:	ZONE 5	CZ 16	CZ 15	ZONE 1	CZ 16	CZ 15	ZONE 5	ZONE 1
		% CONT.:	50.	47.	3.	0.	46.	37.	17.	0.

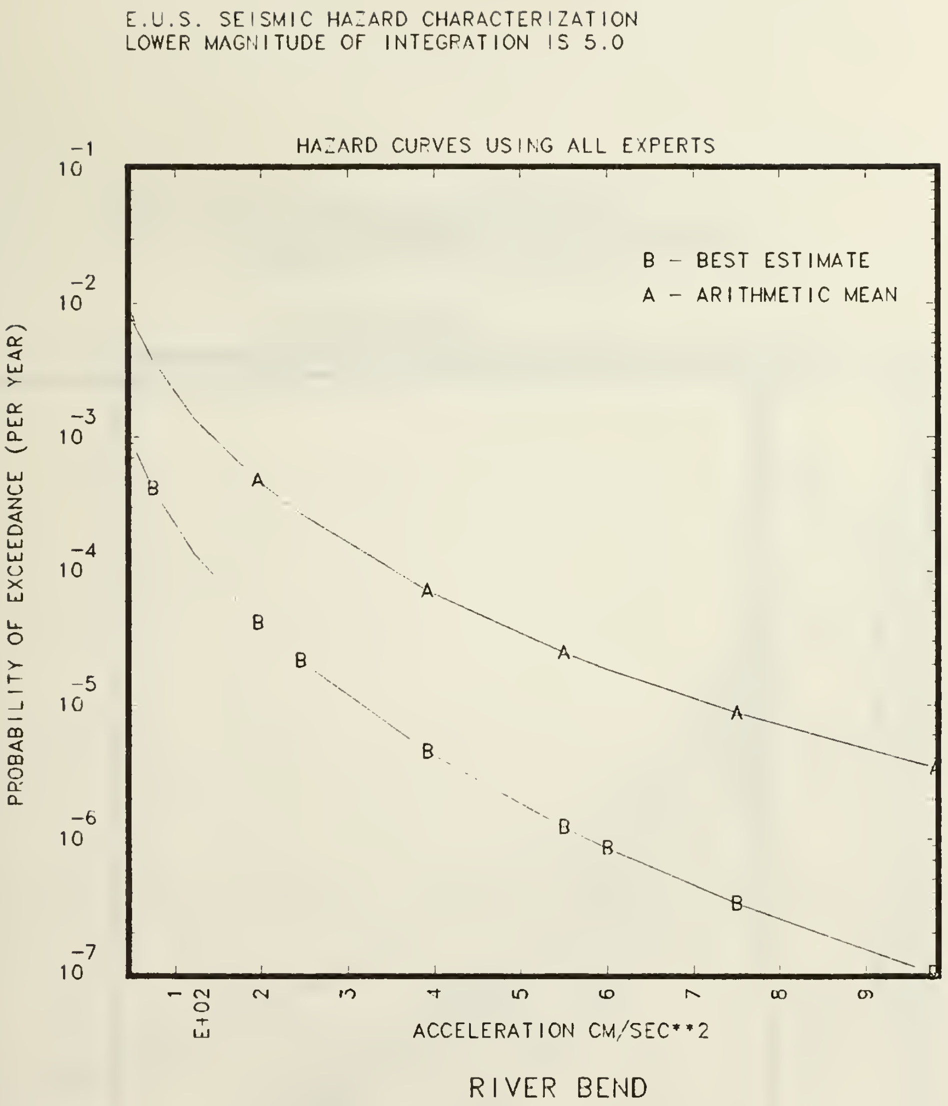

Figure 2.12.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the River Bend site.

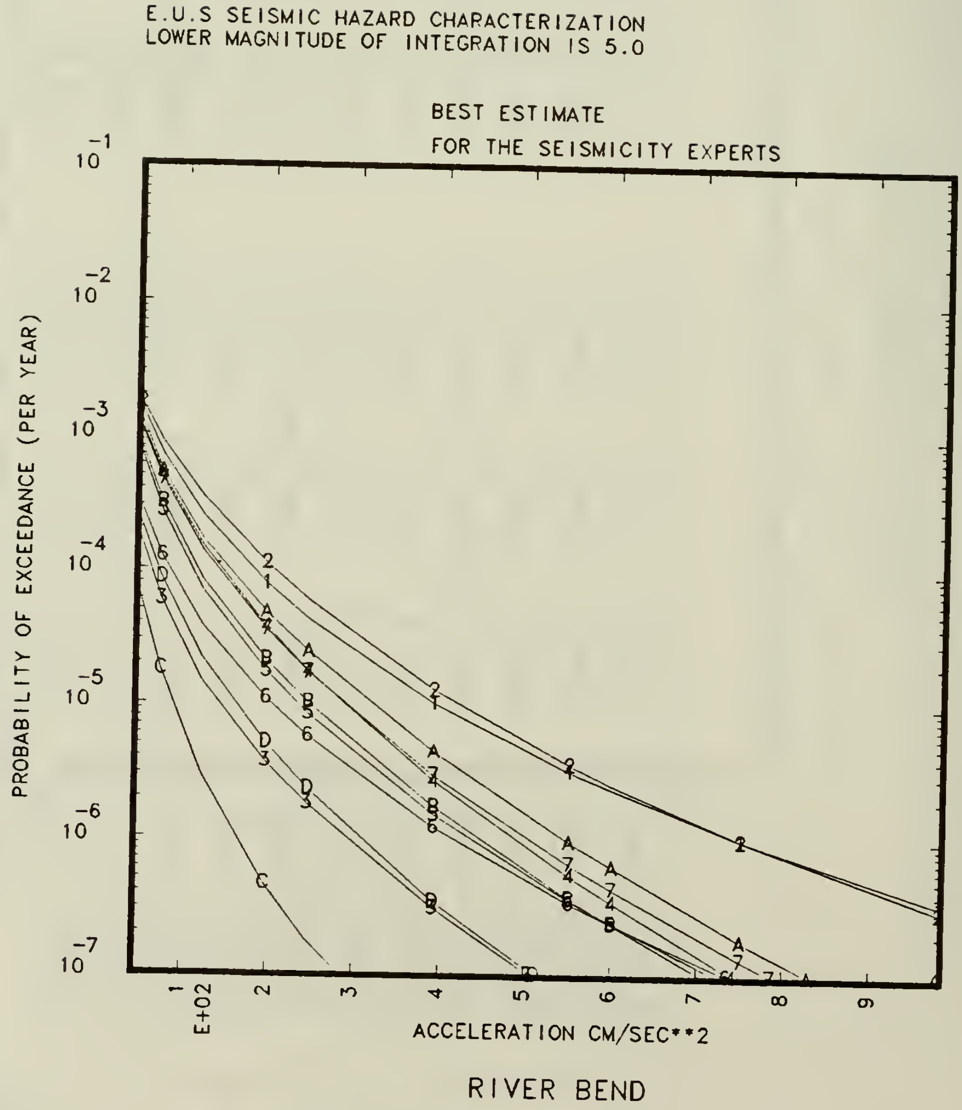

Figure 2.12.2 BEHCs per S-Expert combined over all G-Experts for the River Bend site. Plot symbols given in Table 2.0.

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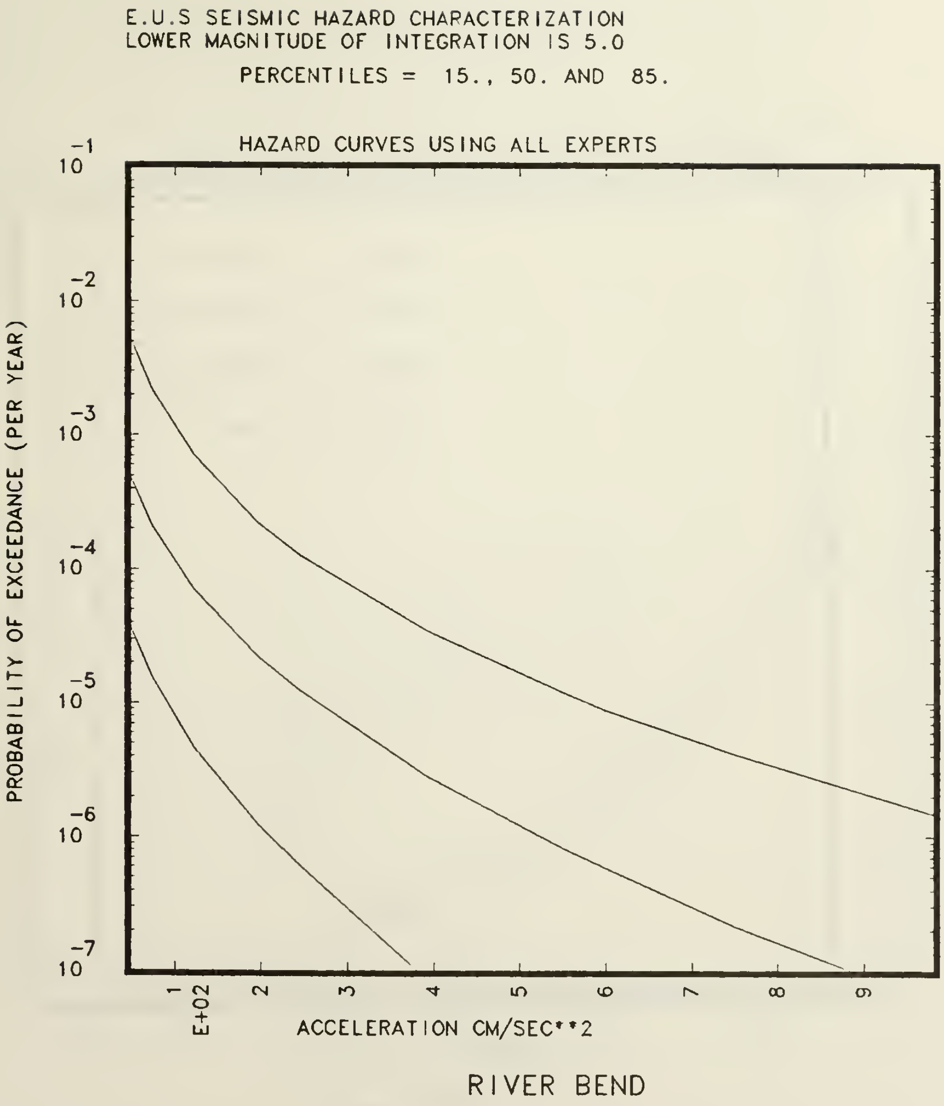

Figure 2.12.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the River Bend site.

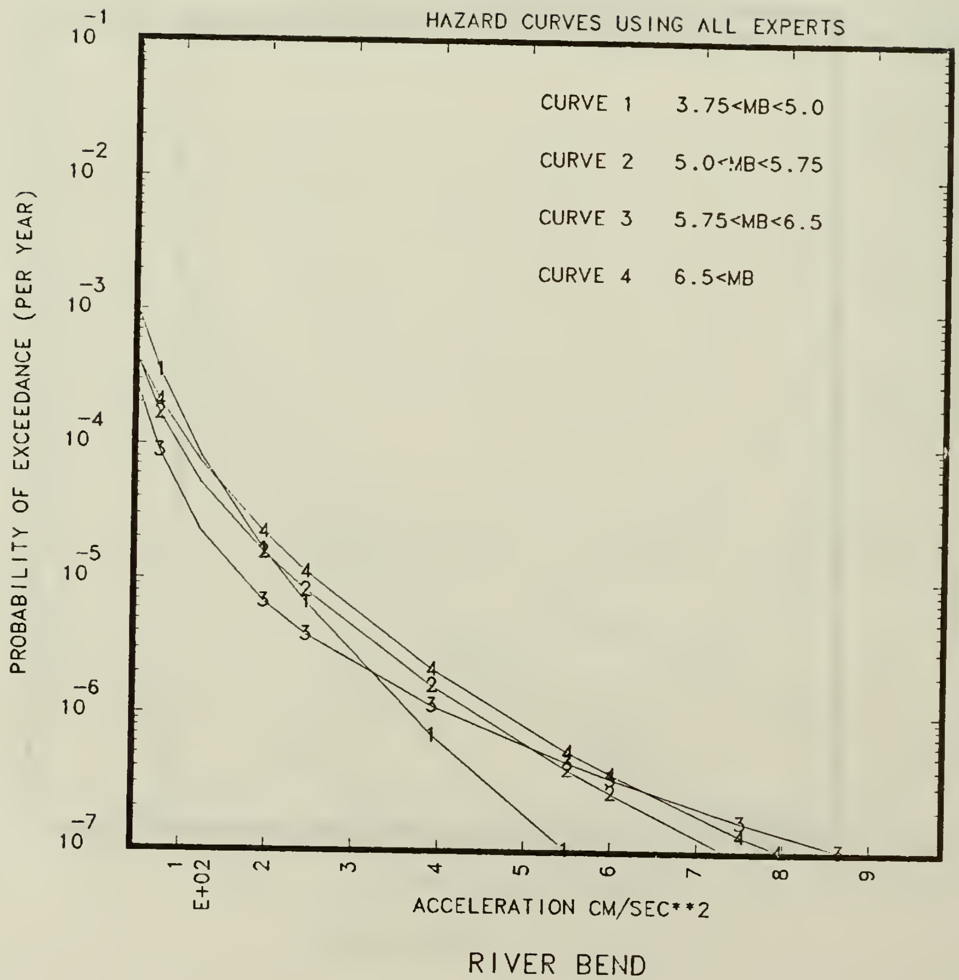

Figure 2.12.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the River Bend site.

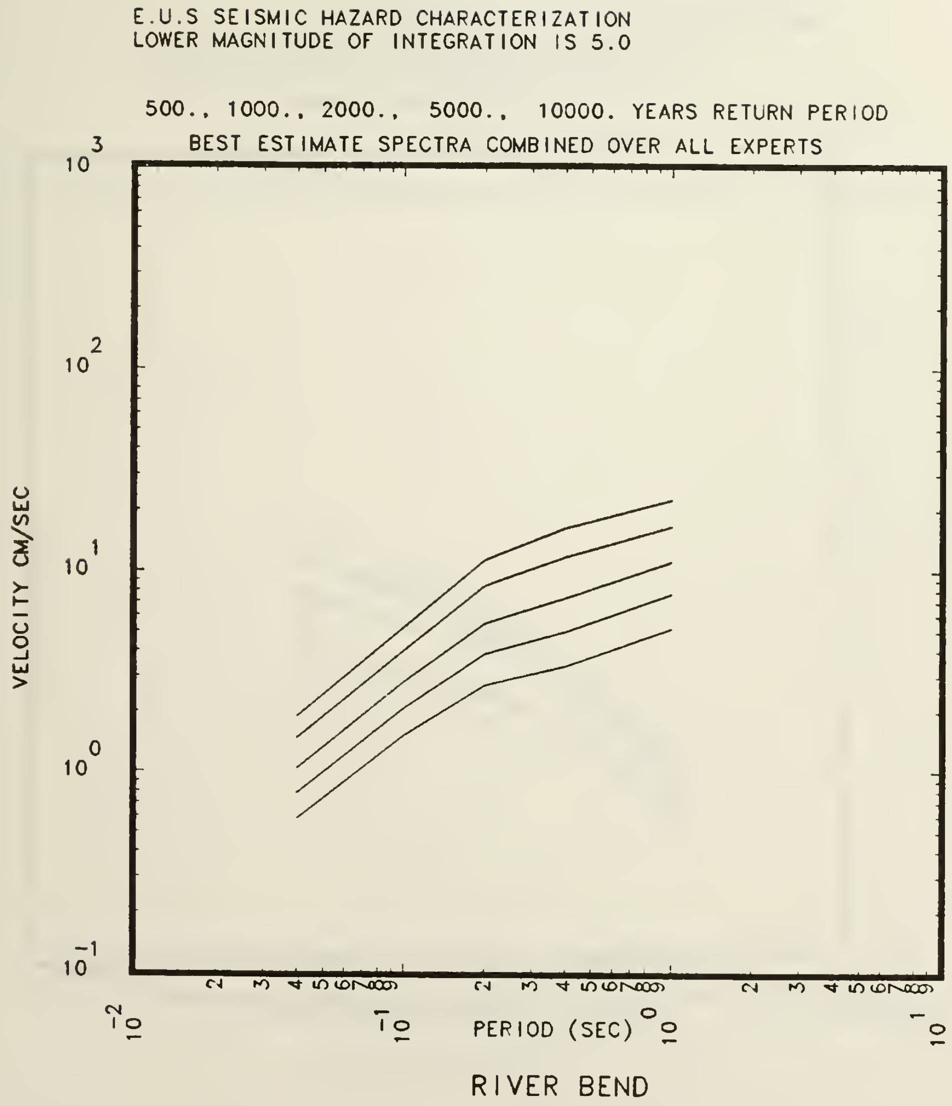

Figure 2.12.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the River Bend site.

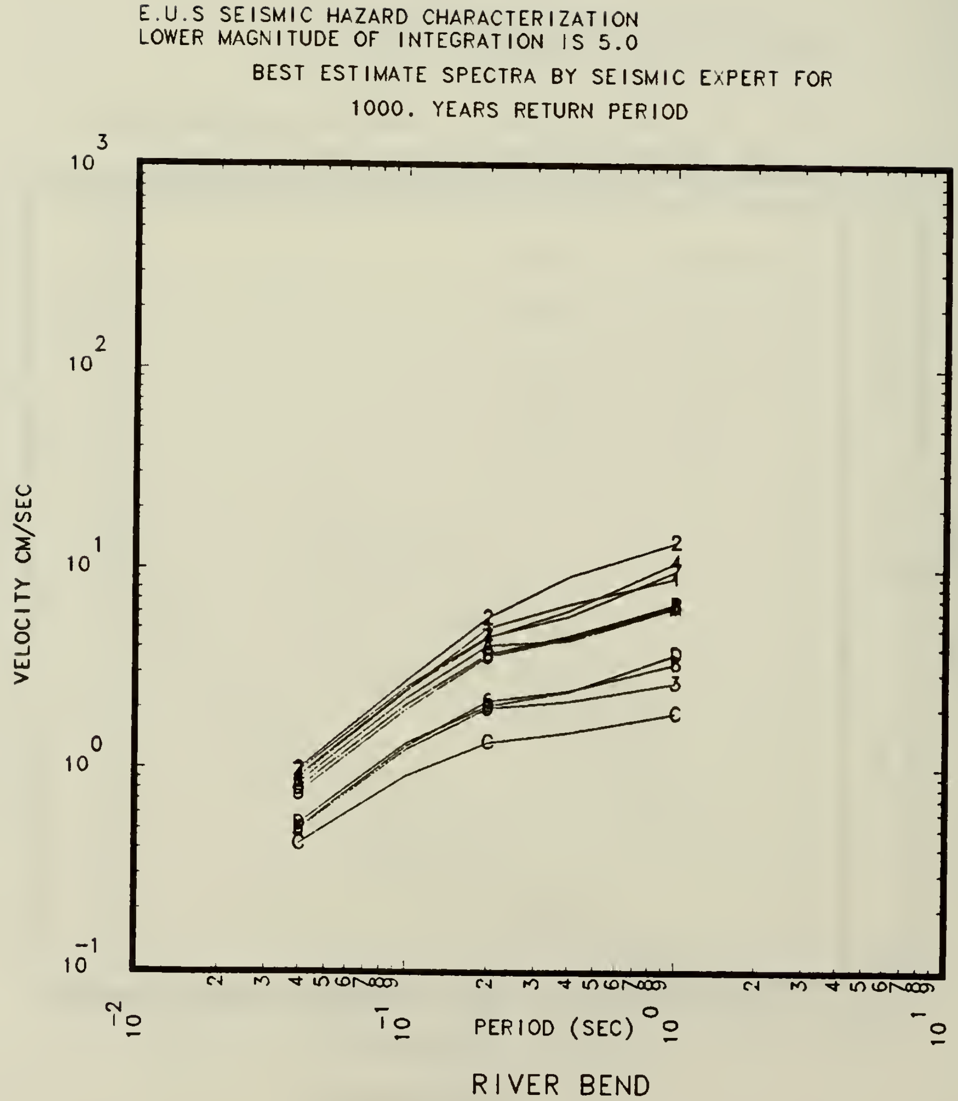

Figure 2.12.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the River Bend site. Plot symbols are given in Table 2.0.

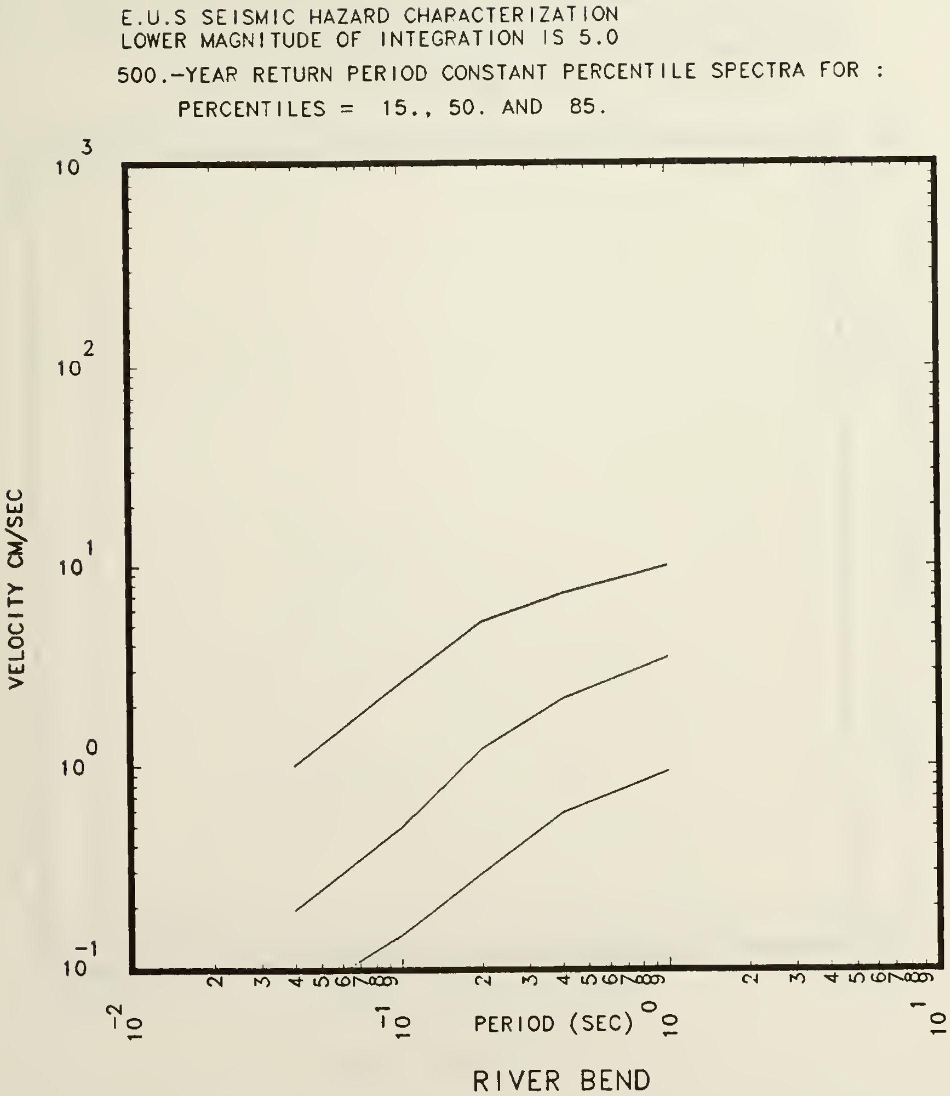

Figure 2.12.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the River Bend site.

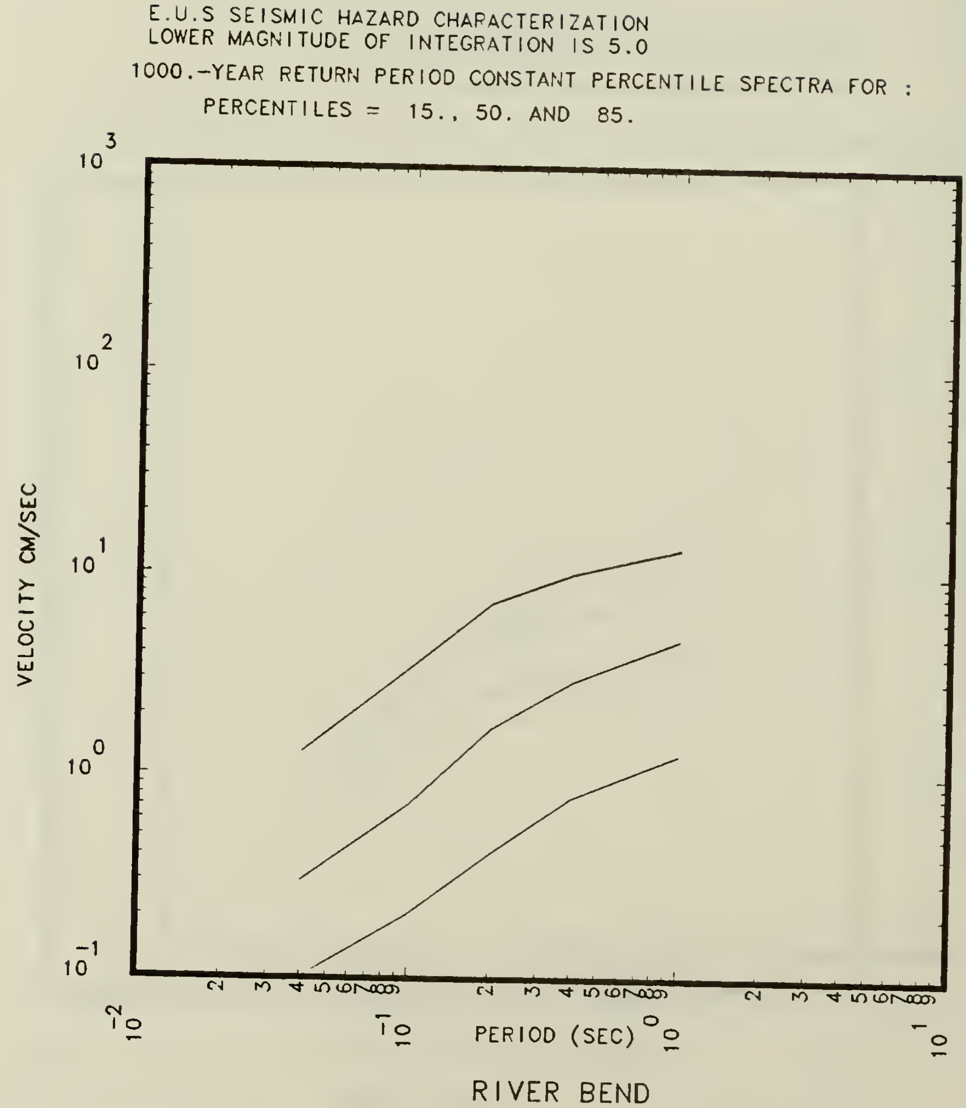

Figure 2.12.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the River Bend site.

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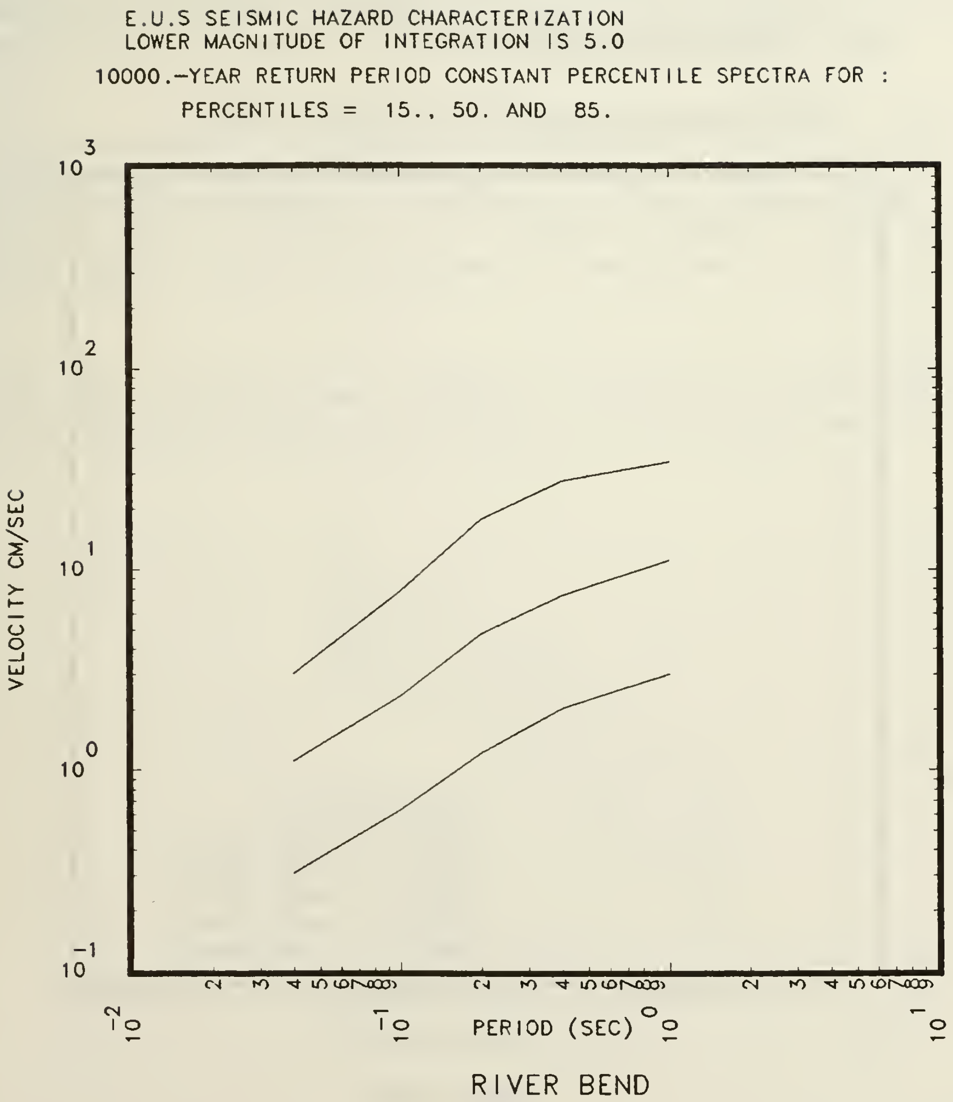

Figure 2.12.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the River Bend site.

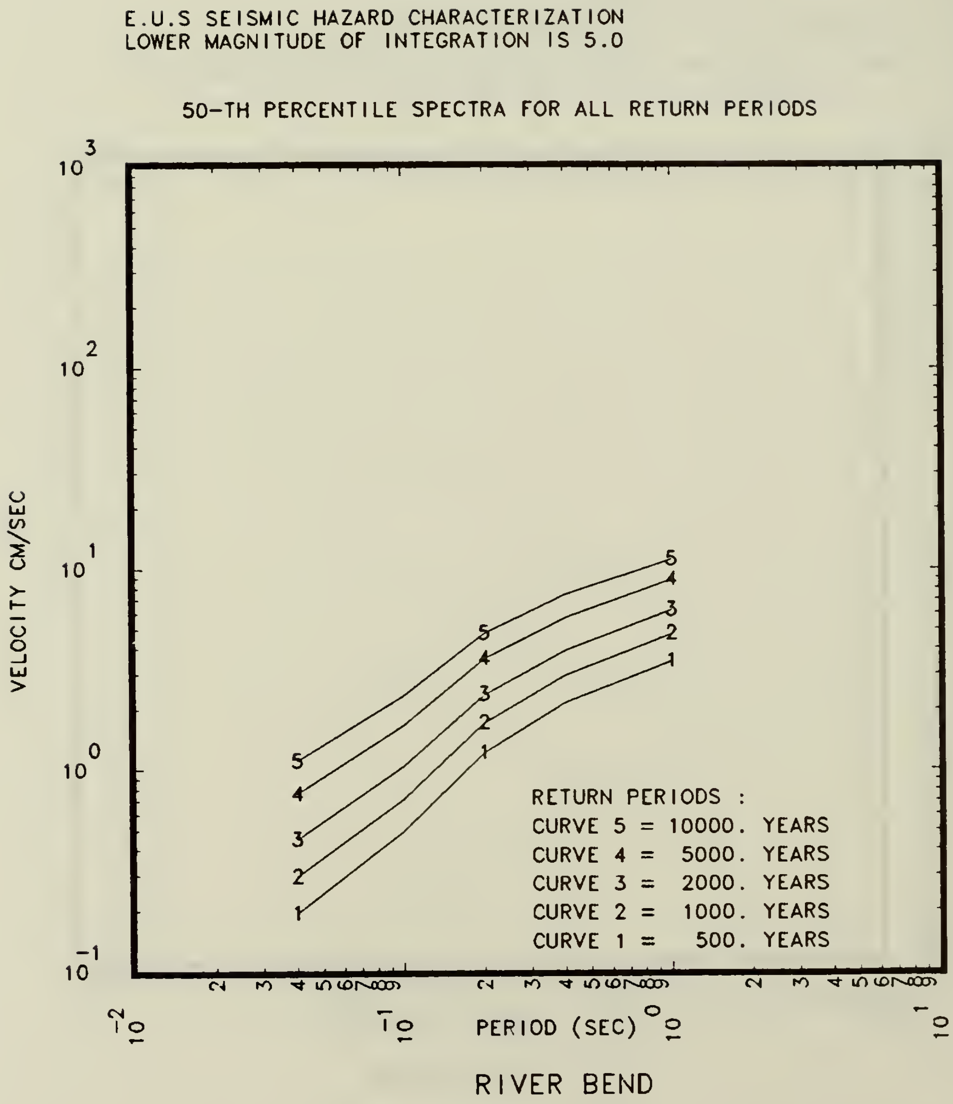

Figure 2.12.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the River Bend site.

2.13 SOUTH TEXAS

South Texas is a deep soil site and is represented by the symbol "D" in Fig. 1.1. Table 2.13.1 and Figs. 2.13.1 to 2.13.10 give the basic results for the South Texas site. Because South Texas is a deep soil site, the G-Expert 5's GM model does not dominate as it does in the case of the rock site as discussed in Sections 2.4 and 2.8.

Table 2.13.1 shows that for all S-Experts but expert 12, the dominant contribution at 0.6g comes from the host zone and the same is true for all but experts 12 and 4 at 0.125g. Thus a discrimination of the hazard by distance bins would show the clear dominance of near site earthquakes, (i.e. dominant contribution from earthquakes within 15 km of the site).

Similar discrimination of earthquake contribution by magnitude bins shows a clear dominance of small to medium earthquakes with a much smaller contribution from earthquake in the last bin (i.e., greater than 6.5). Thus including the small earthquakes in the range up to PGA = 0.2g would modify the BEHC significantly and, on the contrary, it would not affect the BEHC above 0.3g.

The spread between the G-Experts' BEHCs is relatively similar to that shown in Fig. 2.4.1, because the major contribution to the hazard comes from the host zone.

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TABLE 2.13.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR SOUTH TEXAS

SITE SOIL CATEGORY DEEP-SOIL

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 1	ZONE ID:	ZONE 1	ZONE 5	ZONE 6	ZONE 4	ZONE 1	ZONE 4	ZONE 5	ZONE 6
		% CONT.:	99.	1.	0.	0.	100.	0.	0.	0.
2	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 18	ZONE 1	ZONE 2	COMP. ZON	ZONE 18	ZONE 1	ZONE 2
		% CONT.:	91.	9.	0.	0.	99.	1.	0.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 10	ZONE 13	ZONE 12	COMP. ZON	ZONE 13	ZONE 5	ZONE 8A
		% CONT.:	97.	3.	0.	0.	100.	0.	0.	0.
4	COMP. ZO	ZONE ID:	ZONE 4	COMP. ZON	ZONE 25	ZONE 3	COMP. ZON	ZONE 25	ZONE 4	ZONE 1
		% CONT.:	67.	18.	15.	0.	69.	17.	14.	0.
5	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 15	ZONE 17	ZONE 11	COMP. ZON	ZONE 15	ZONE 10	ZONE 11
		% CONT.:	58.	38.	3.	0.	83.	17.	0.	0.
6	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 20	ZONE 25	ZONE 17	COMP. ZON	ZONE 20	ZONE 12	ZONE 18
		% CONT.:	93.	6.	1.	0.	100.	0.	0.	0.
7	ZONE 1	ZONE ID:	ZONE 1	ZONE 35	ZONE 2 =	ZONE 30	ZONE 1	ZONE 2 =	ZONE 5	ZONE 30
		% CONT.:	92.	4.	4.	0.	88.	12.	0.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 29	ZONE 32	ZONE 19 =	ZONE 19 =	ZONE 29	ZONE 32	ZONE 19 =
		% CONT.:	100.	0.	0.	100.	100.	0.	0.	100.
11	ZONE 14	ZONE ID:	ZONE 14	CZ = ZONE	ZONE 11	ZONE 15	ZONE 14	CZ = ZONE	ZONE 6	ZONE 8
		% CONT.:	90.	7.	2.	1.	77.	23.	0.	0.
12	ZONE 10	ZONE ID:	ZONE 3	ZONE 8	ZONE 1	ZONE 14	ZONE 3	ZONE 15	ZONE 1	ZONE 6
		% CONT.:	67.	31.	1.	1.	100.	0.	0.	0.
13	CZ 16	ZONE ID:	CZ 16	CZ 15	ZONE 1	ZONE 3	CZ 16	CZ 15	ZONE 1	ZONE 3
		% CONT.:	93.	7.	0.	0.	54.	46.	0.	0.

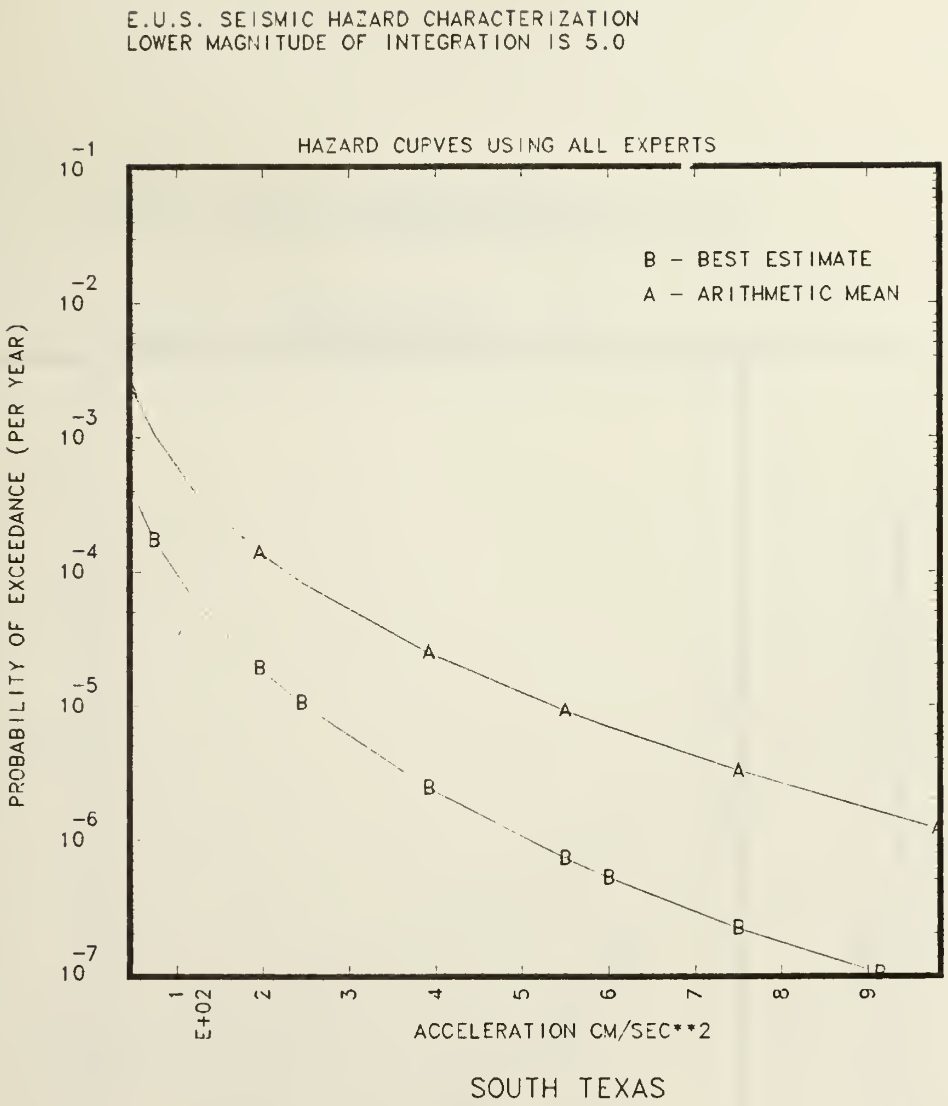

Figure 2.13.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the South Texas site.

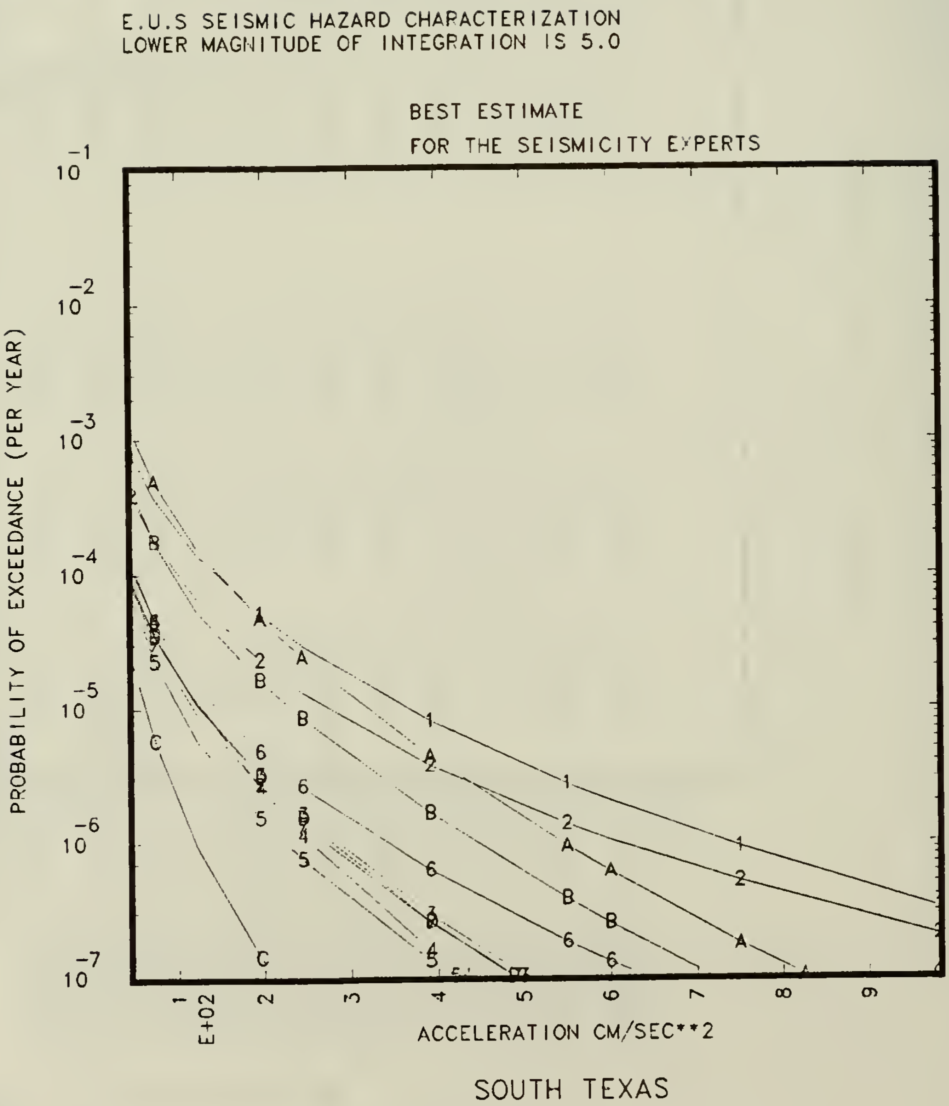

Figure 2.13.2 BEHCs per S-Expert combined over all G-Experts for the South Texas site. Plot symbols given in Table 2.0.

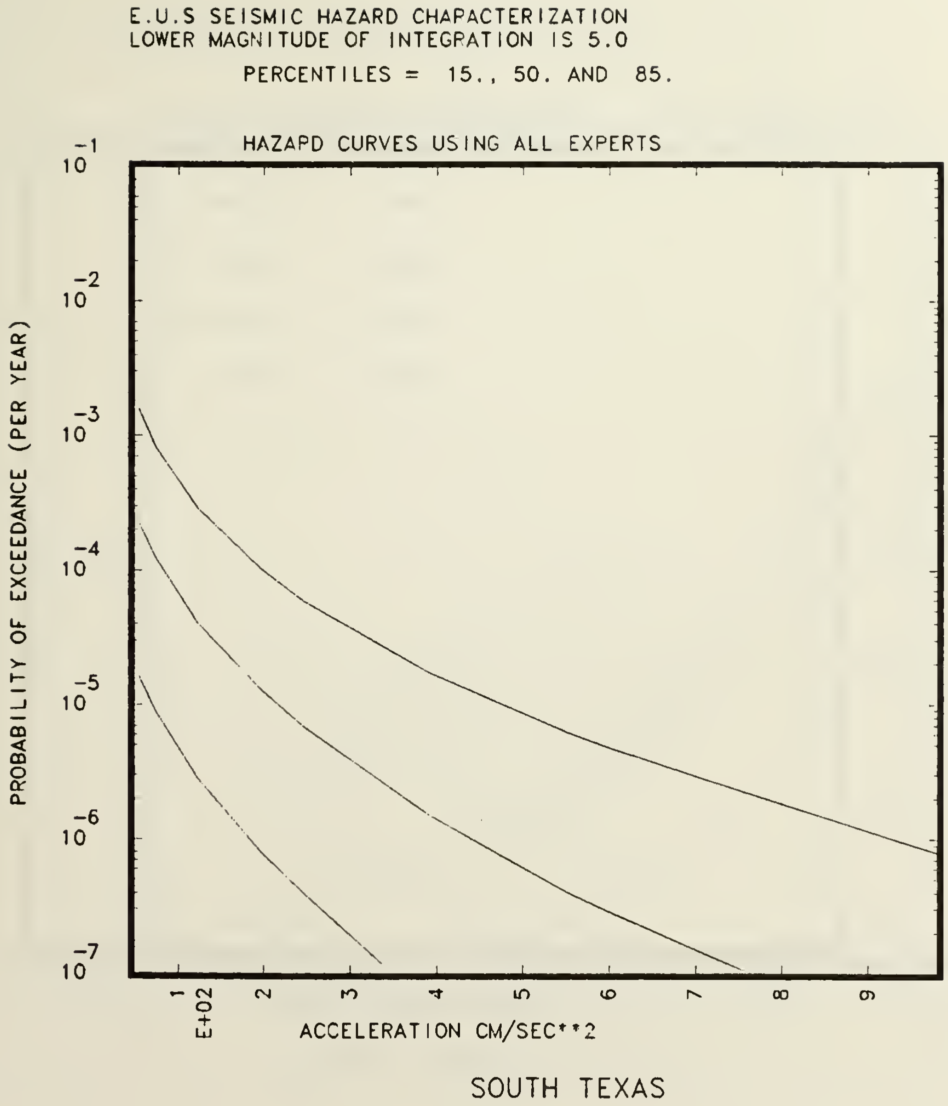

Figure 2.13.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the South Texas site.

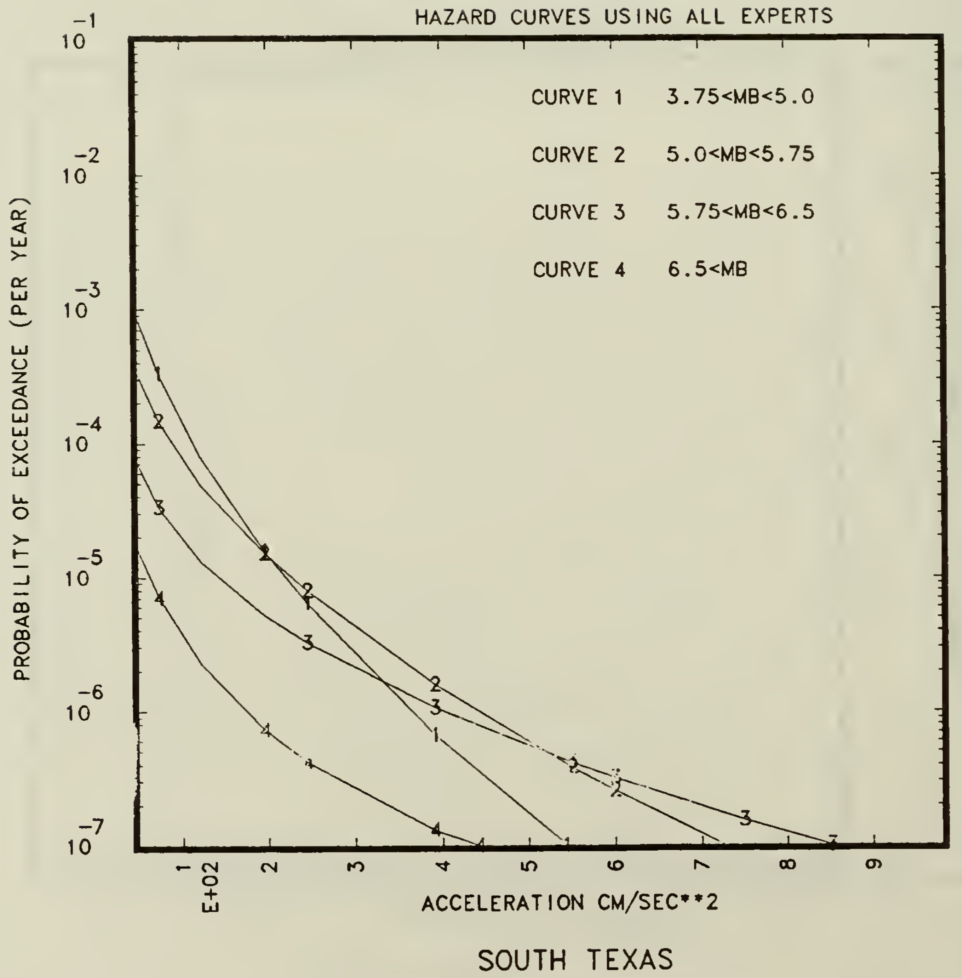

Figure 2.13.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the South Texas site.

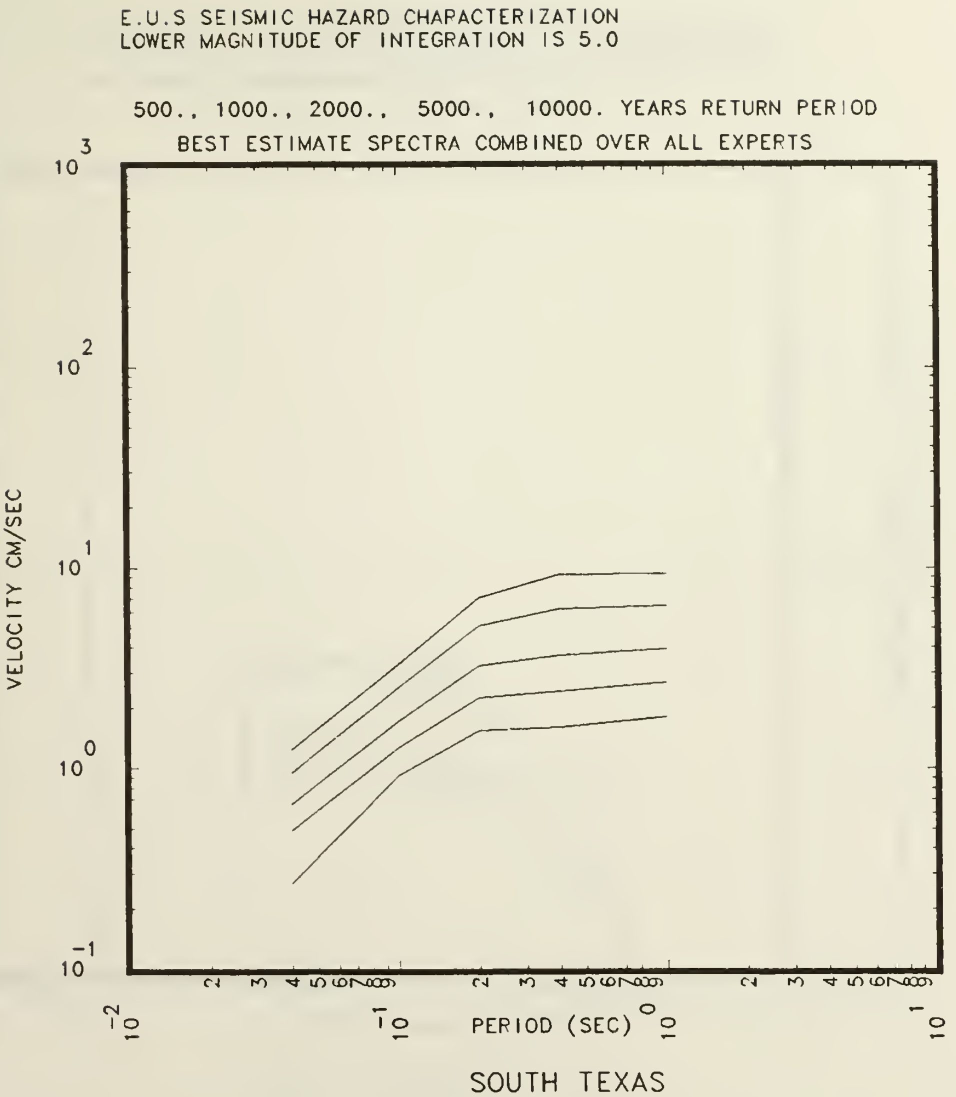

Figure 2.13.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the South Texas site.

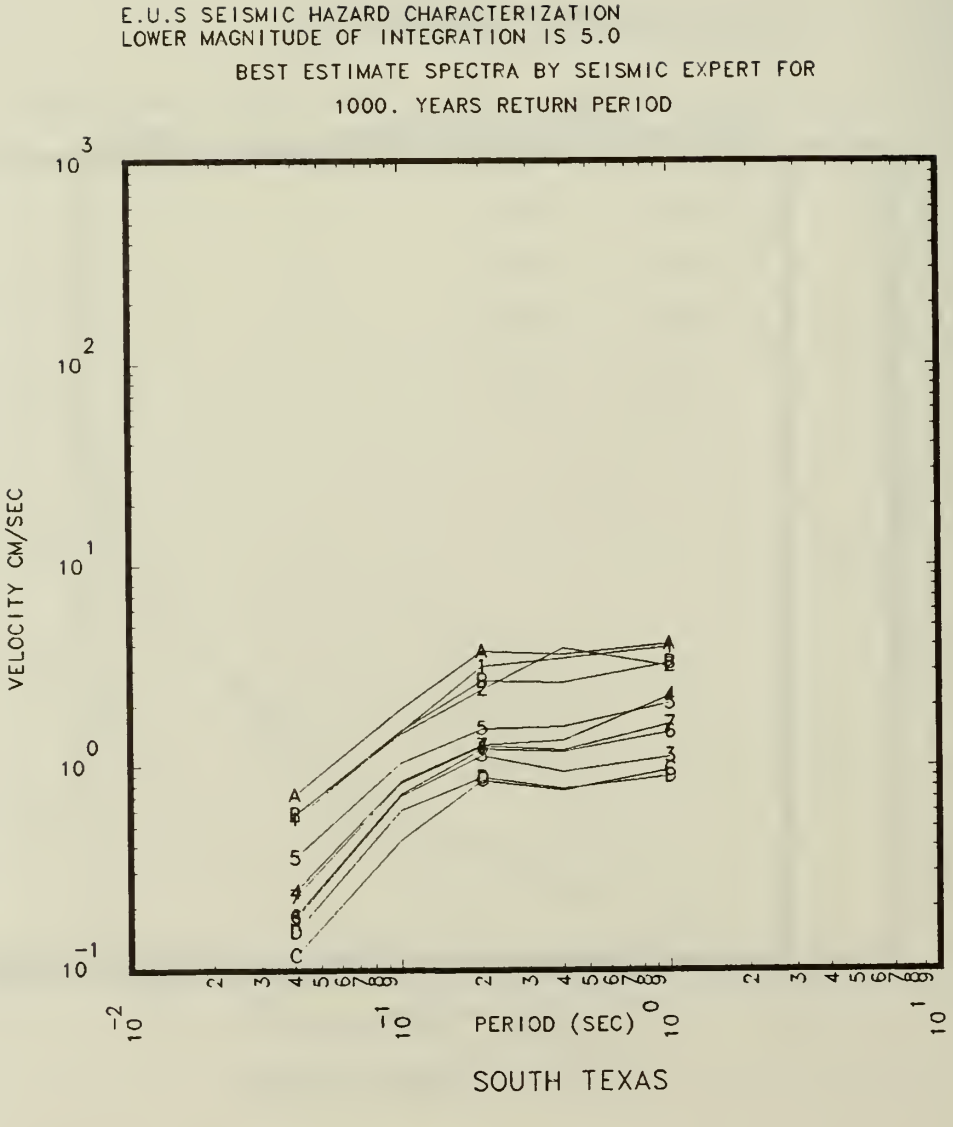

Figure 2.13.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the South Texas site. Plot symbols are given in Table 2.0.

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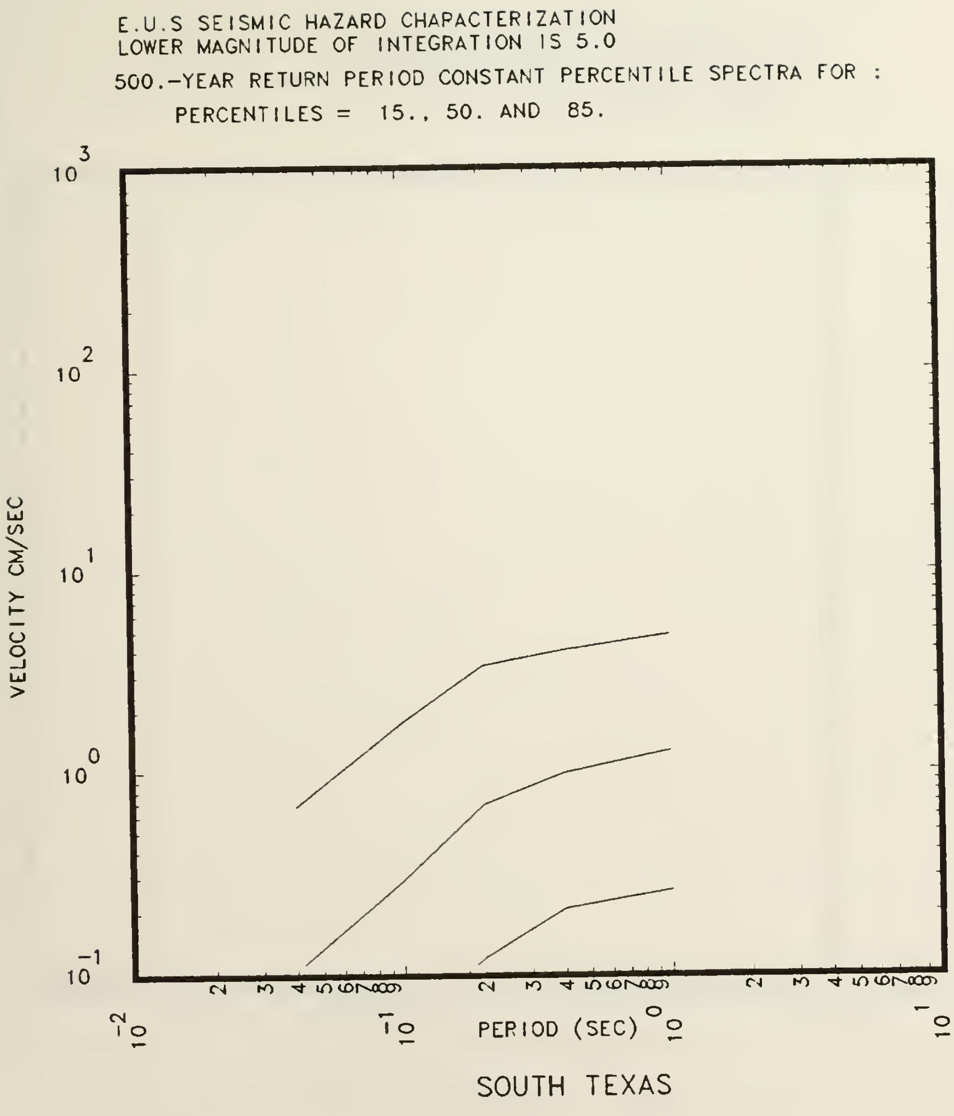

Figure 2.13.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the South Texas site.

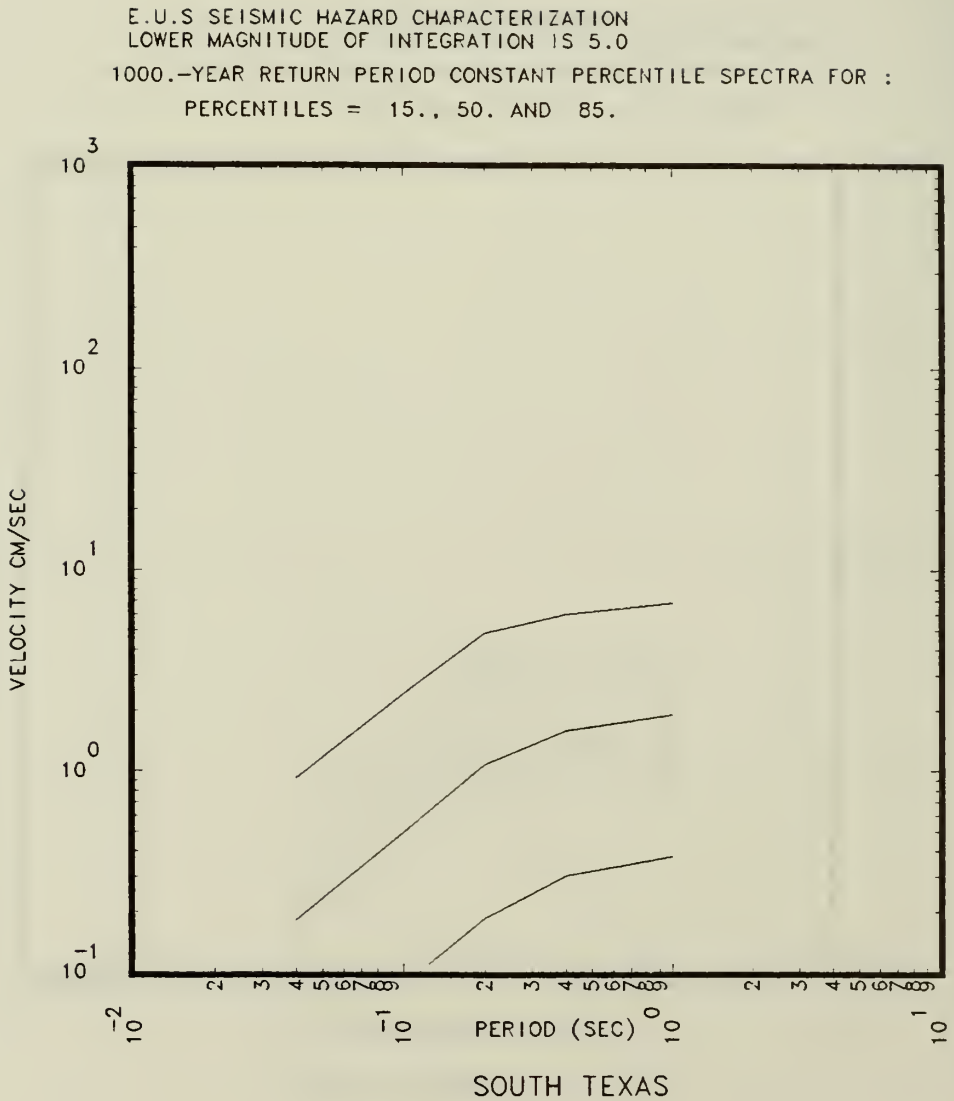

Figure 2.13.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the South Texas site.

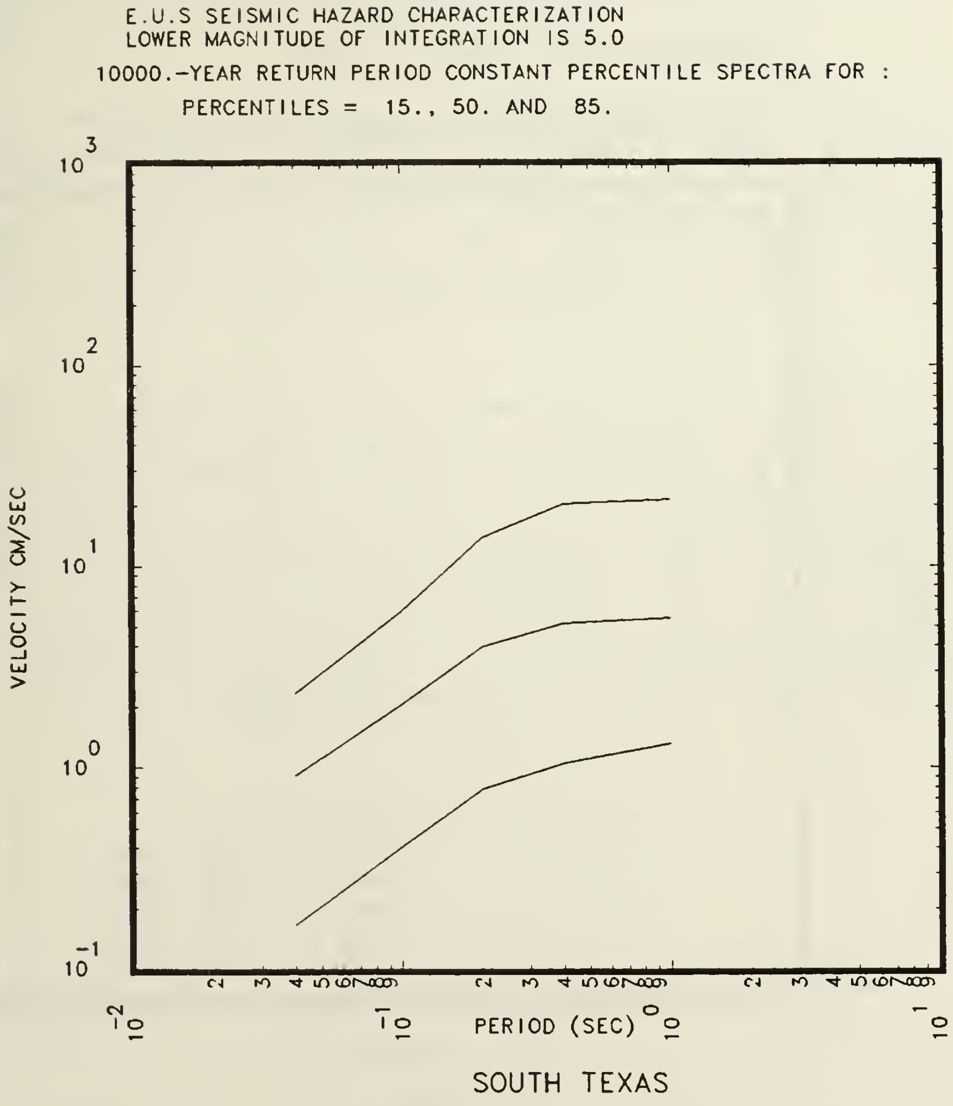

Figure 2.13.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the South Texas site.

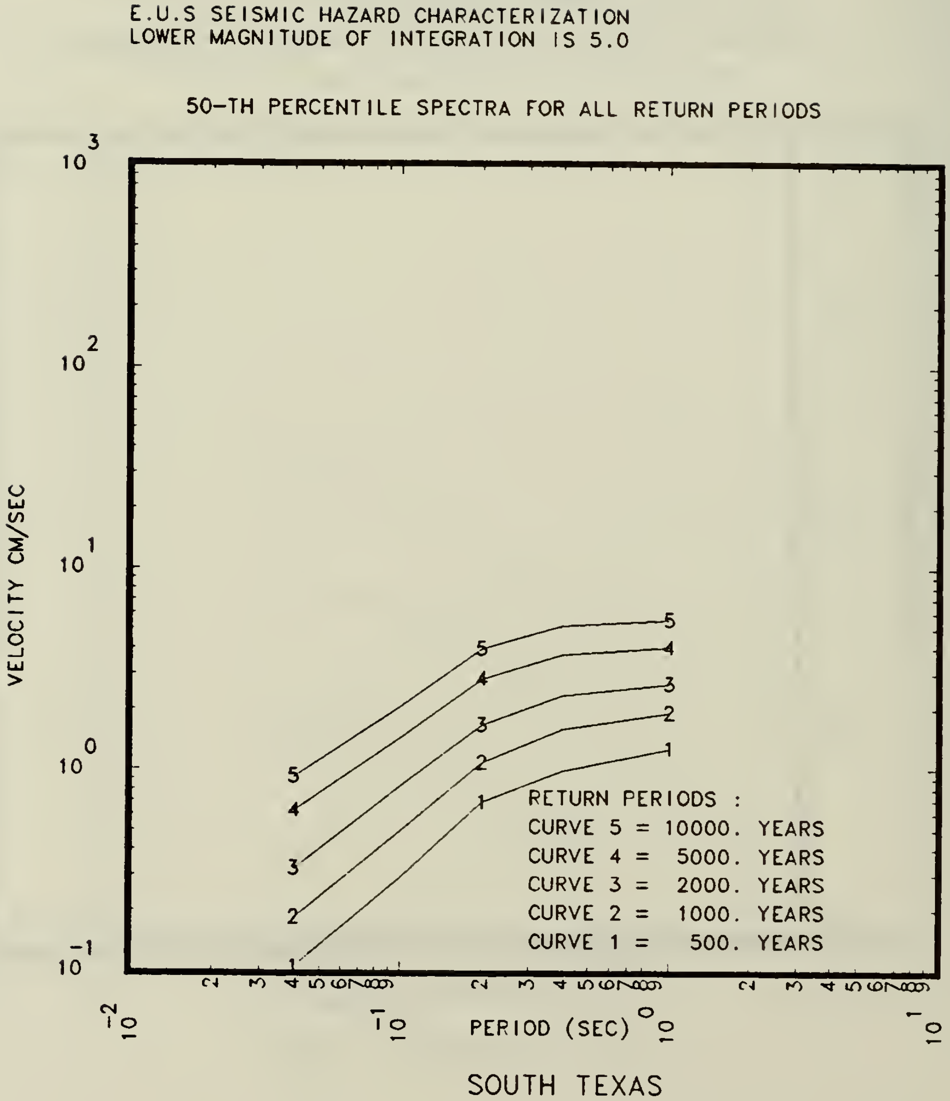

Figure 2.13.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the South Texas site.

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2.14 ST. LUCIE

St. Lucie is a deep soil site and is represented by the symbol "E" in Fig. 1.1. Table 2.14.4 and Figs. 2.14.1 to 2.14.10 give the basic results for the St. Lucie site. Because St. Lucie is a deep soil site, the G-Expert 5's GM model does not dominate as it does in the case of the rock site (See Section 2.4).

Table 2.14.1 shows that for all S-Experts but S-Experts 5 and 12, the dominant contribution comes from the host zone. Thus a discrimination of the hazard by distance bins shows, Fig. 2.4.11, the clear dominance of near site earthquakes.

Similar discrimination of earthquake contribution by magnitude bins, Fig. 2.14.1, shows a clear dominance of earthquakes greater than magnitude 6.5 with much smaller contribution from earthquake in the first two bins (i.e. 3.75 to 5.00) at high PGA. By contrast, the small earthquakes (3.75 to 5.00) dominate for PGA smaller than 0.2g. Thus including the small earthquakes in the range up to PGA = 0.2g would modify the BEHC significantly and, on the contrary, it would not affect the BEHC above 0.2g.

There appears to be a contradiction between Figs. 2.14.4 and 2.14.11. Figure 2.14.4 suggests that large (and considering the location of St. Lucie) distant earthquakes dominate. Yet Fig. 2.14.11 indicates that nearby earthquakes dominate. However, if Fig. 2.14.2 is examined it is observed that S-Expert 11's BEHC is much higher than the others and thus dominates the combined BEHC. We see from the maps in Appendix A that St. Lucie is in S-Expert 11's zone 8 which is the Charleston zone. This allows large earthquakes to occur near the site. In addition, S-Expert 2 set the upper magnitude cutoff in his CZ at 7.6. Thus, these two inputs tend to dominate the BEHC. This is, as noted a number of times, one of the weak points of the BEHC.

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TABLE 2.14.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR ST. LUCIE

SITE SOIL CATEGORY DEEP-SOIL

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 1	ZONE ID:	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 1	ZONE 2	ZONE 3	ZONE 4
		% CONT.:	97.	3.	0.	0.	100.	0.	0.	0.
2	COMP. ZO	ZONE ID:	ZONE 30	COMP. ZON	ZONE 29	ZONE 27	COMP. ZON	ZONE 30	ZONE 27	ZONE 29
		% CONT.:	61.	39.	0.	0.	92.	8.	0.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 9	ZONE 8	ZONE 8A	COMP. ZON	ZONE 5	ZONE 7	ZONE 9
		% CONT.:	97.	3.	0.	0.	100.	0.	0.	0.
4	ZONE 25	ZONE ID:	ZONE 25	ZONE 10	COMP. ZON	ZONE 9	ZONE 25	COMP. ZON	ZONE 28	ZONE 8
		% CONT.:	63.	36.	1.	0.	98.	2.	0.	0.
5	ZONE 21	ZONE ID:	ZONE 9	ZONE 21	COMP. ZON	ZONE 8	ZONE 9	ZONE 21	COMP. ZON	ZONE 8
		% CONT.:	84.	15.	1.	0.	49.	47.	4.	0.
6	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 13	ZONE 16	ZONE 11	COMP. ZON	ZONE 13	ZONE 11	ZONE 12
		% CONT.:	72.	27.	0.	0.	99.	1.	0.	0.
7	ZONE 1	ZONE ID:	ZONE 10	ZONE 1	ZONE 2 =	ZONE 7	ZONE 1	ZONE 2 =	ZONE 10	ZONE 7
		% CONT.:	46.	42.	12.	0.	84.	11.	5.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 15	ZONE 4B	ZONE 28	ZONE 19 =	ZONE 15	ZONE 4B	ZONE 28
		% CONT.:	99.	1.	0.	0.	100.	0.	0.	0.
11	ZONE 8	ZONE ID:	ZONE 8	CZ = ZONE	ZONE 6	ZONE 7	ZONE 8	CZ = ZONE	ZONE 6	ZONE 7
		% CONT.:	90.	10.	0.	0.	99.	1.	0.	0.
12	ZONE 26	ZONE ID:	ZONE 23A	ZONE 24	ZONE 25	ZONE 23	ZONE 19	ZONE 20	ZONE 21	ZONE 22
		% CONT.:	100.	0.	0.	0.	0.	0.	0.	0.
13	CZ 16	ZONE ID:	CZ 16	ZONE 9	CZ 18	CZ 15	CZ 16	CZ 15	CZ 18	ZONE 8
		% CONT.:	84.	8.	5.	3.	71.	29.	0.	0.

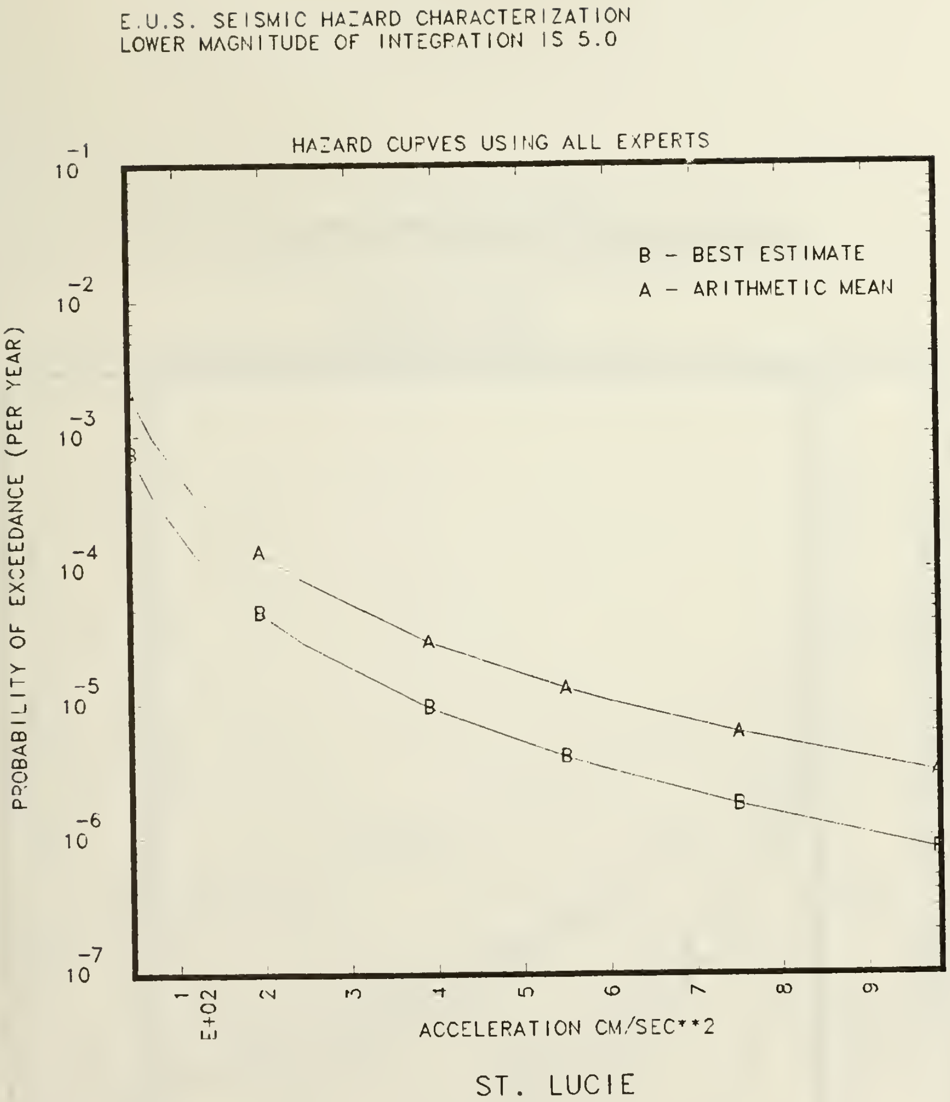

Figure 2.14.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the St. Lucie site.

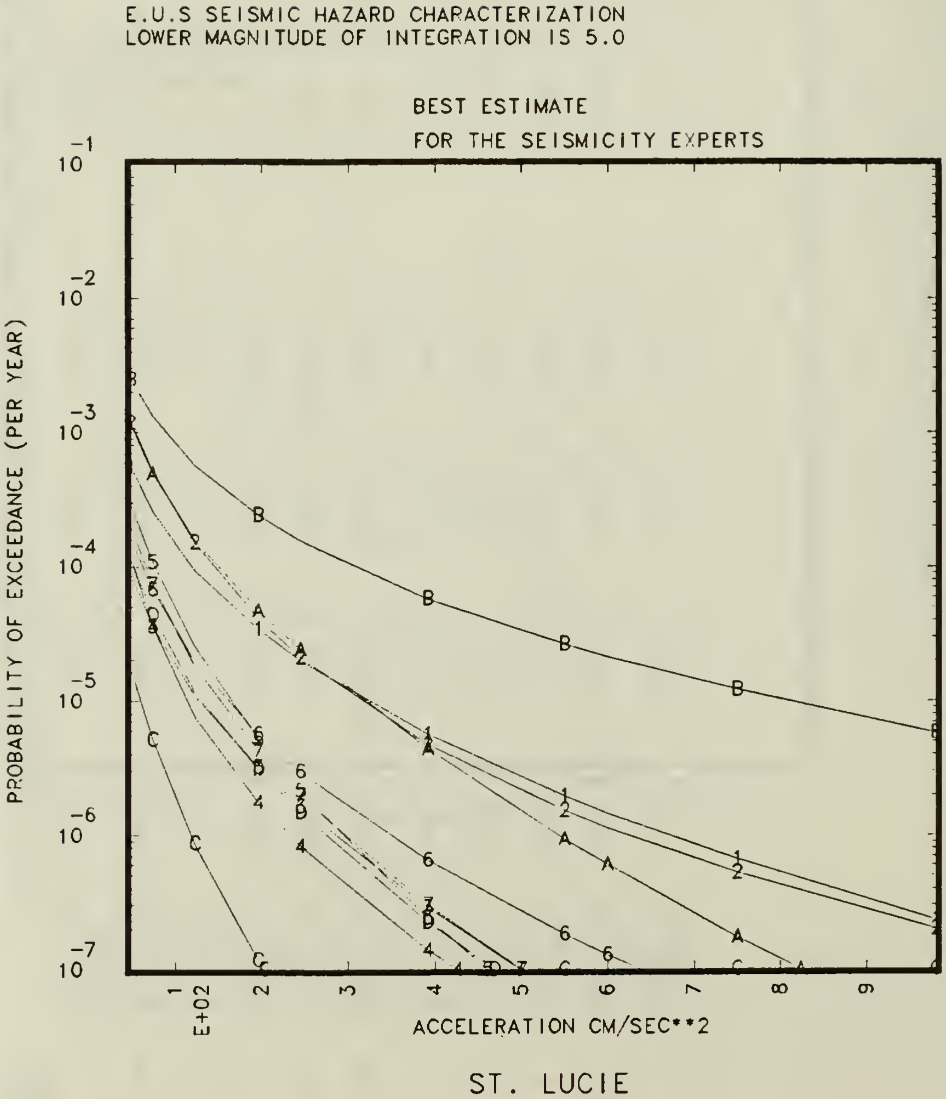

Figure 2.14.2 BEHCs per S-Expert combined over all G-Experts for the St. Lucie site. Plot symbols given in Table 2.0.

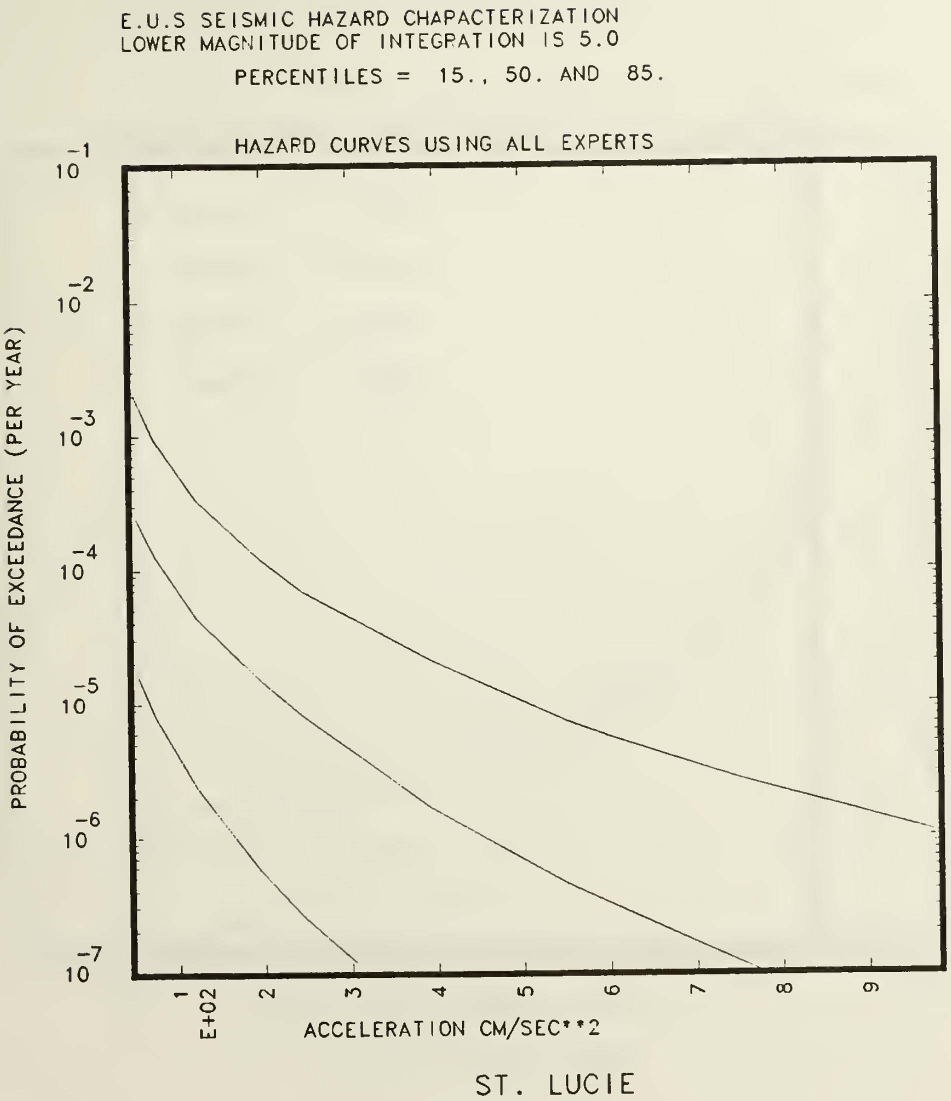

Figure 2.14.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the St. Lucie site.

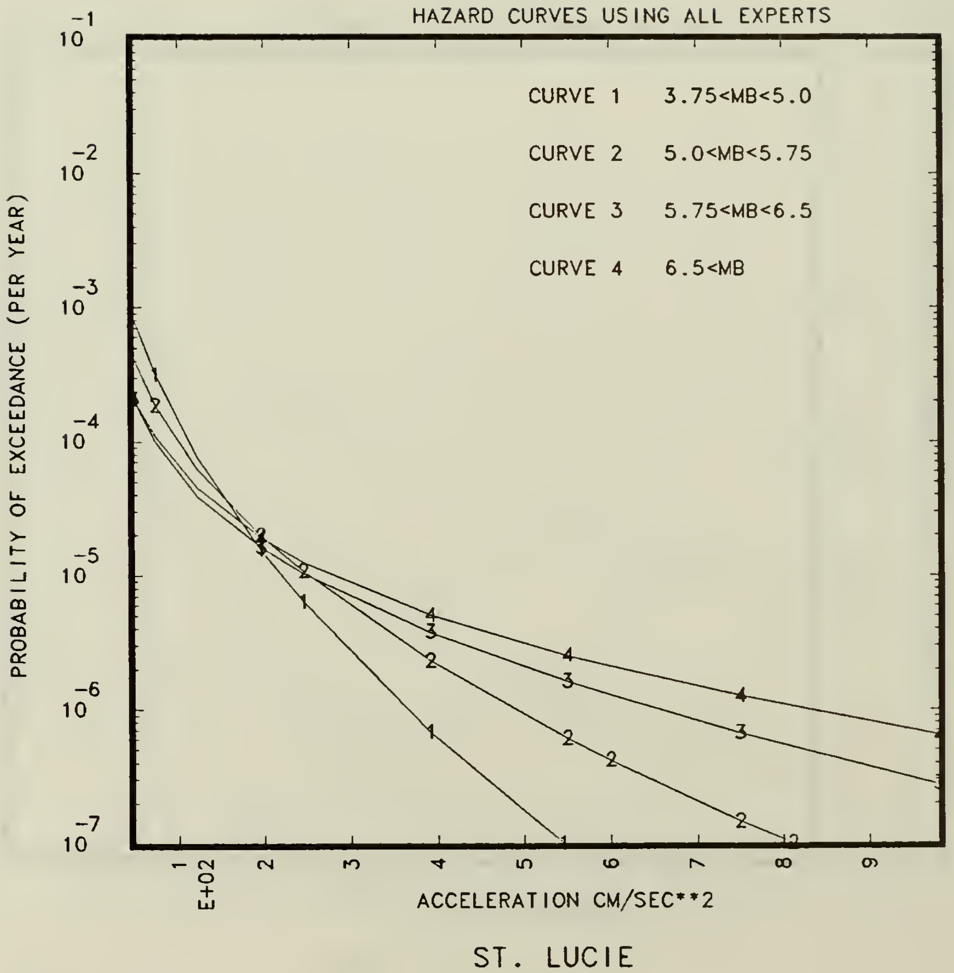

Figure 2.14.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the St. Lucie site.

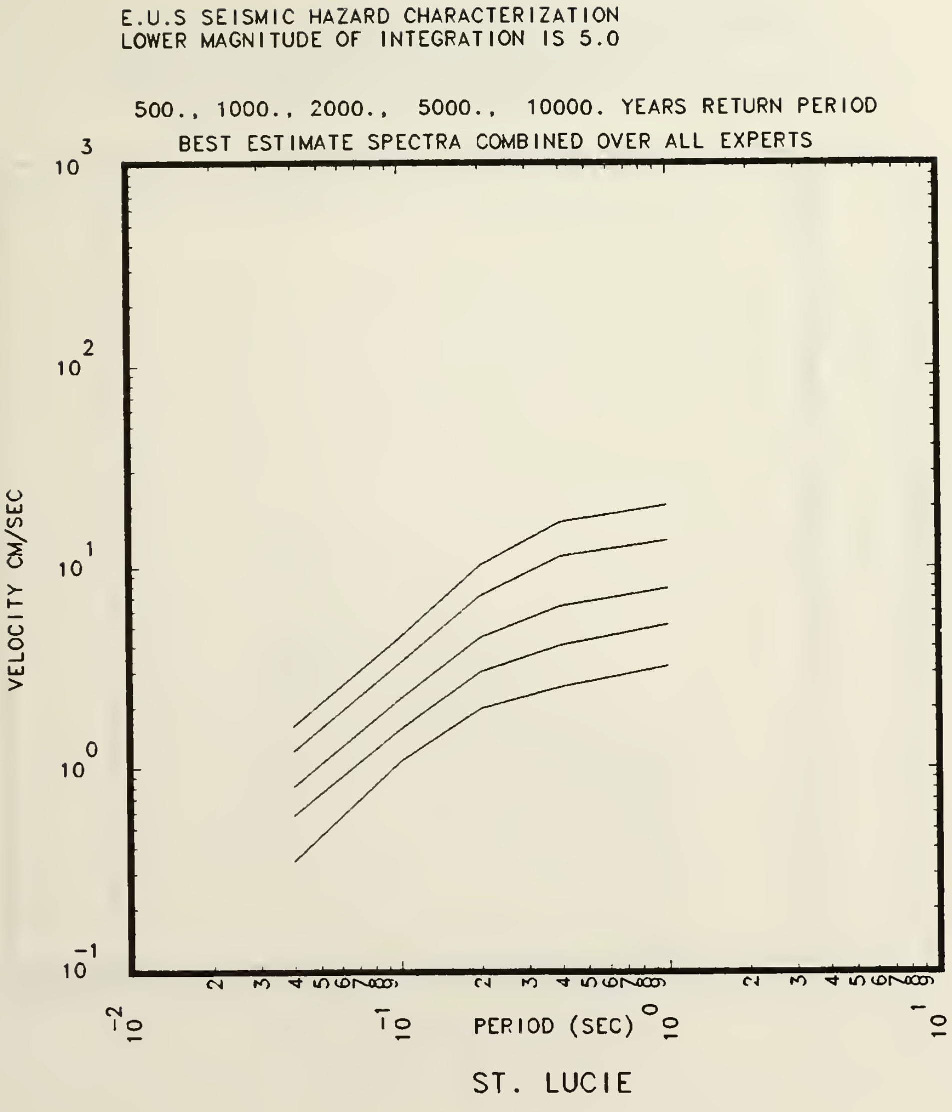

Figure 2.14.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the St. Lucie site.

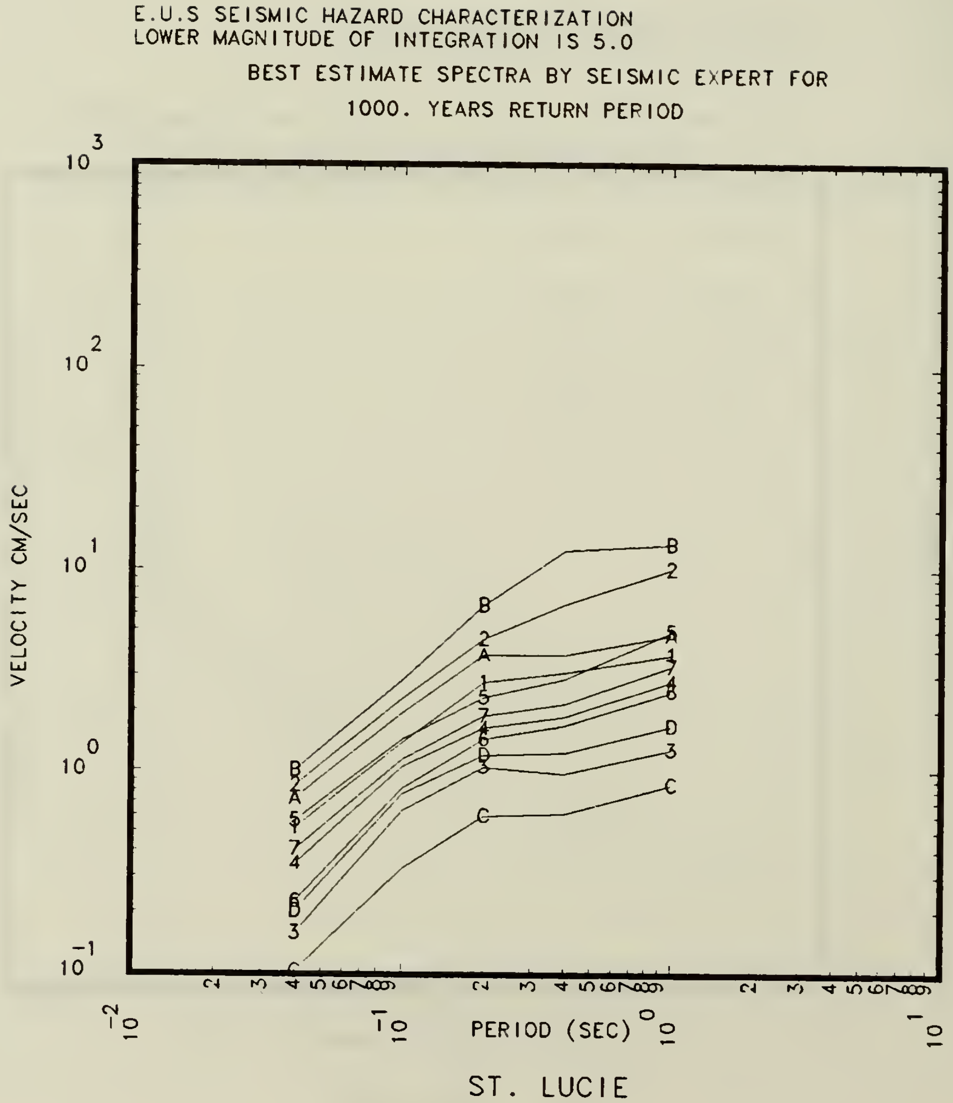

Figure 2.14.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the St. Lucie site. Plot symbols are given in Table 2.0.

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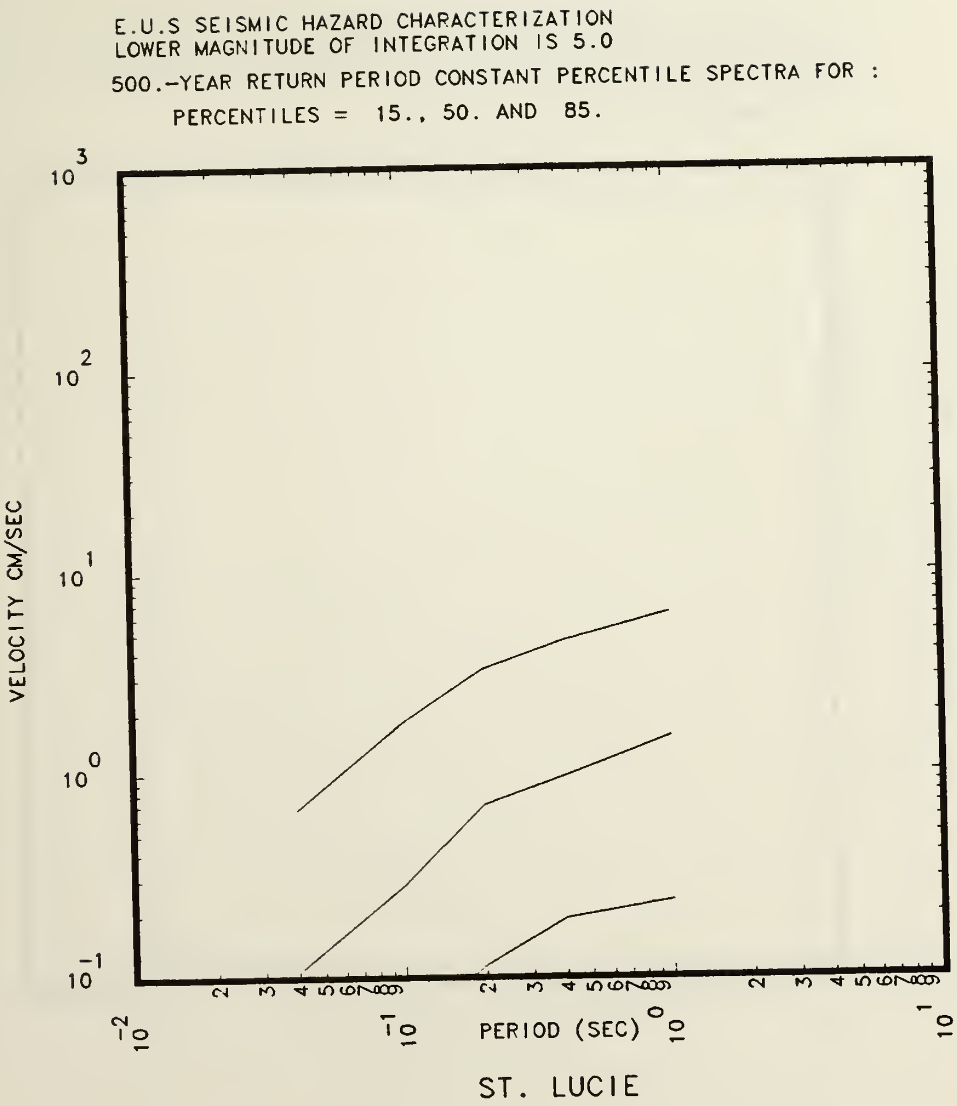

Figure 2.14.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the St. Lucie site.

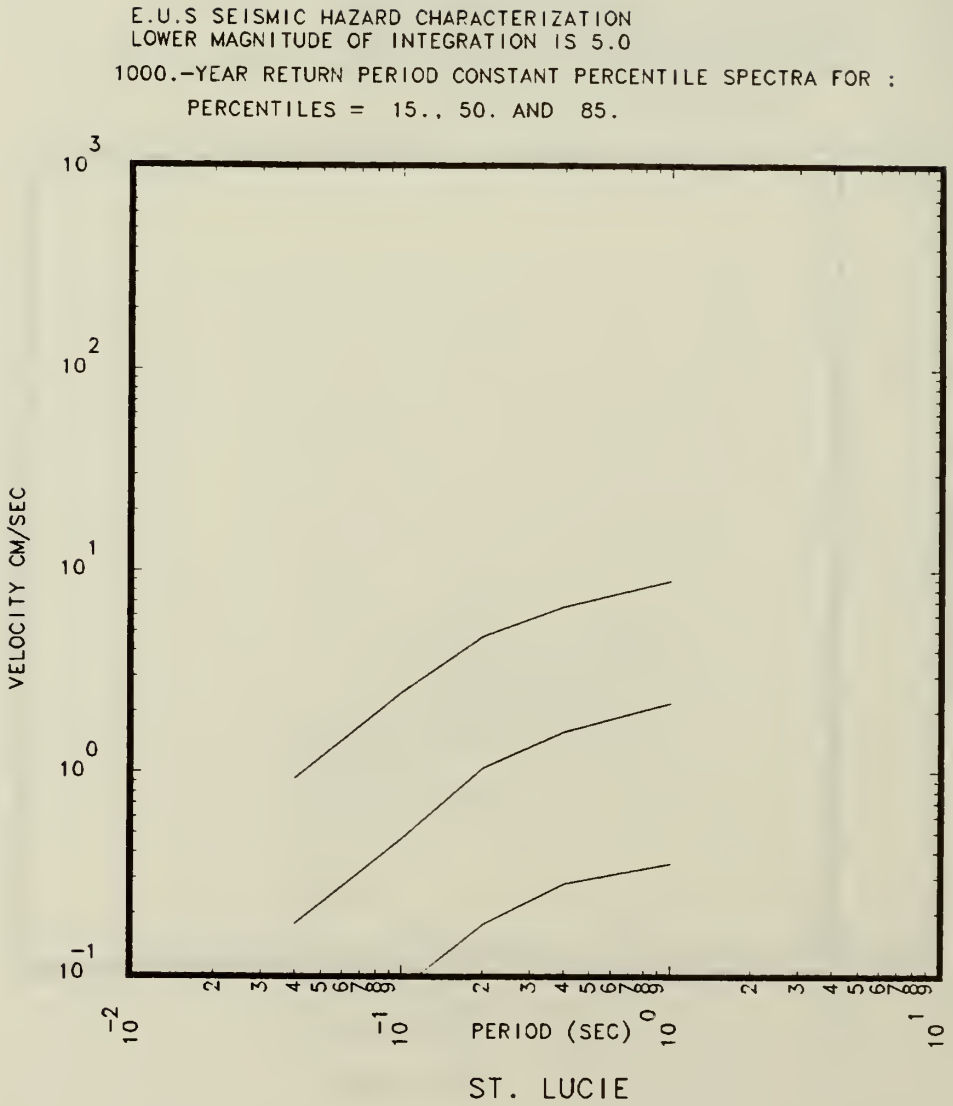

Figure 2.14.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the St. Lucie site.

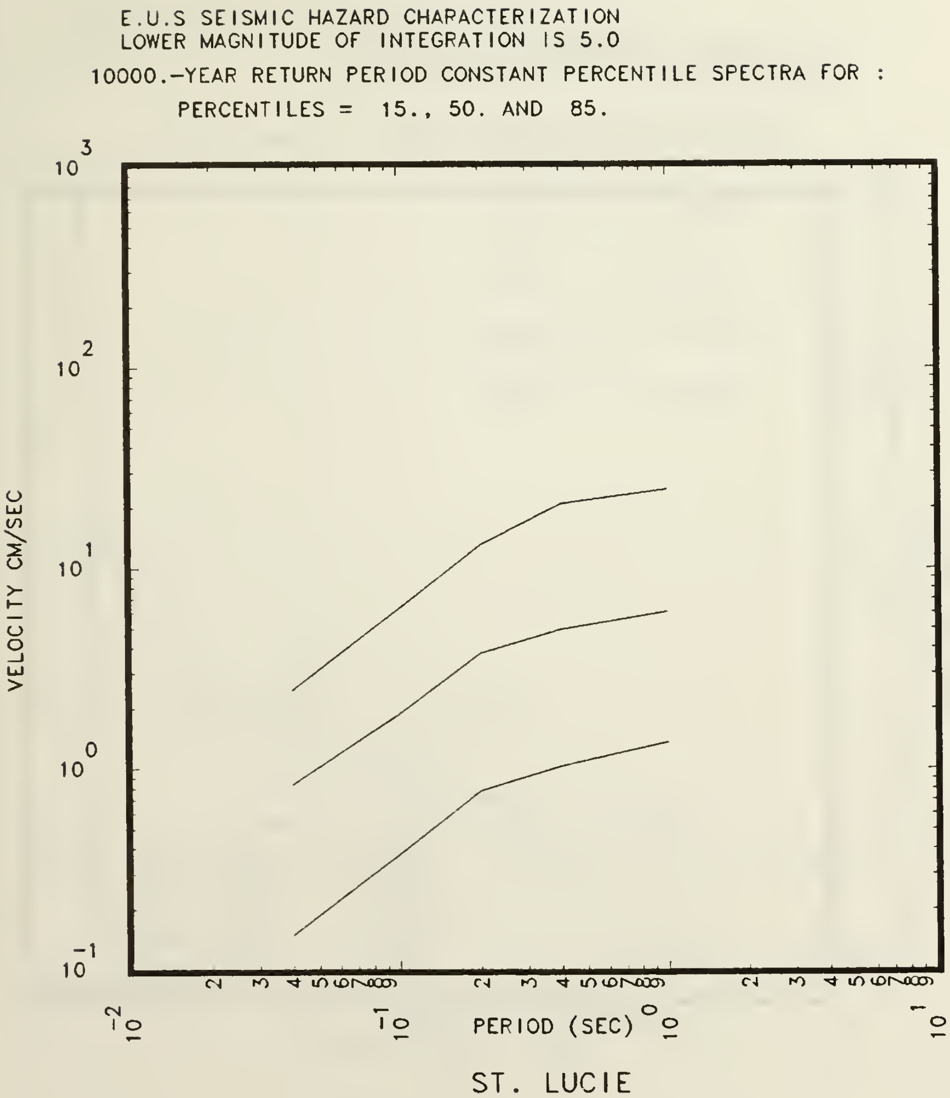

Figure 2.14.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the St. Lucie site.

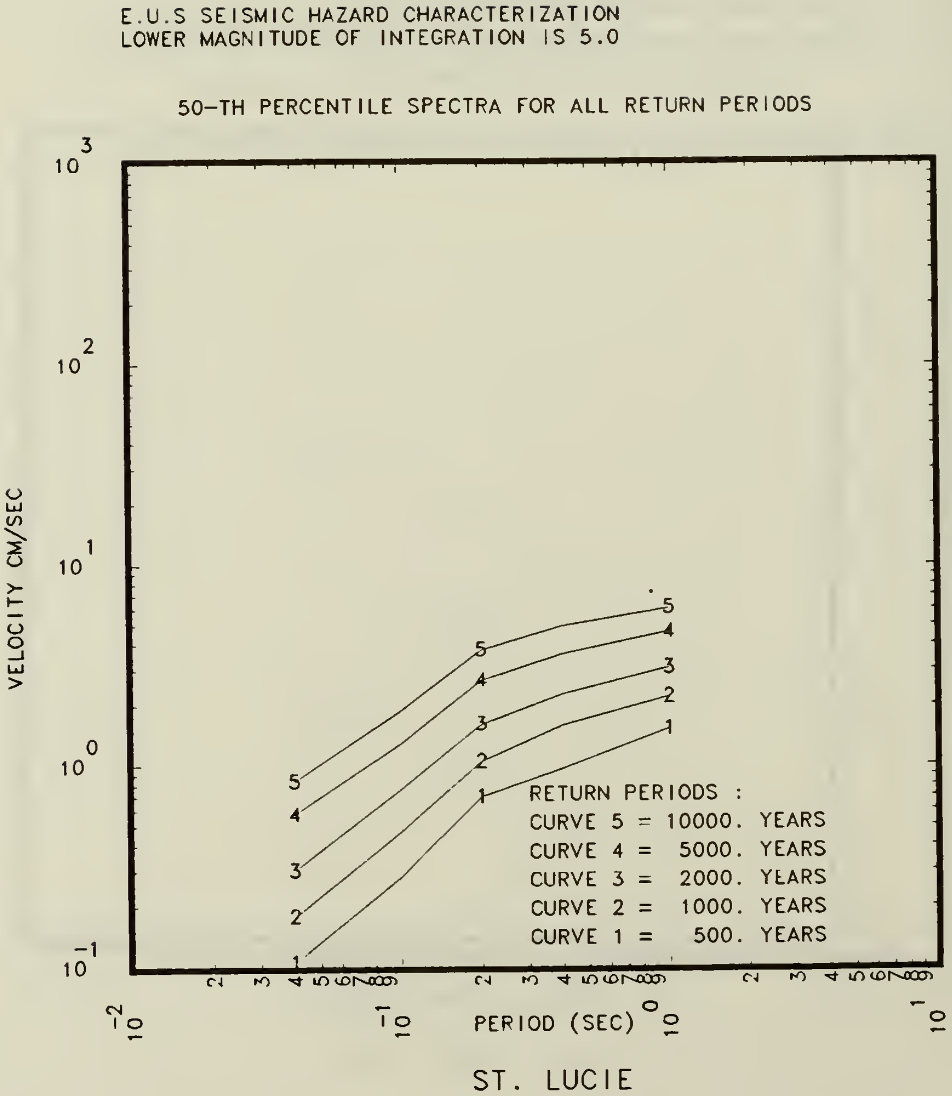

Figure 2.14.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the St. Lucie site.

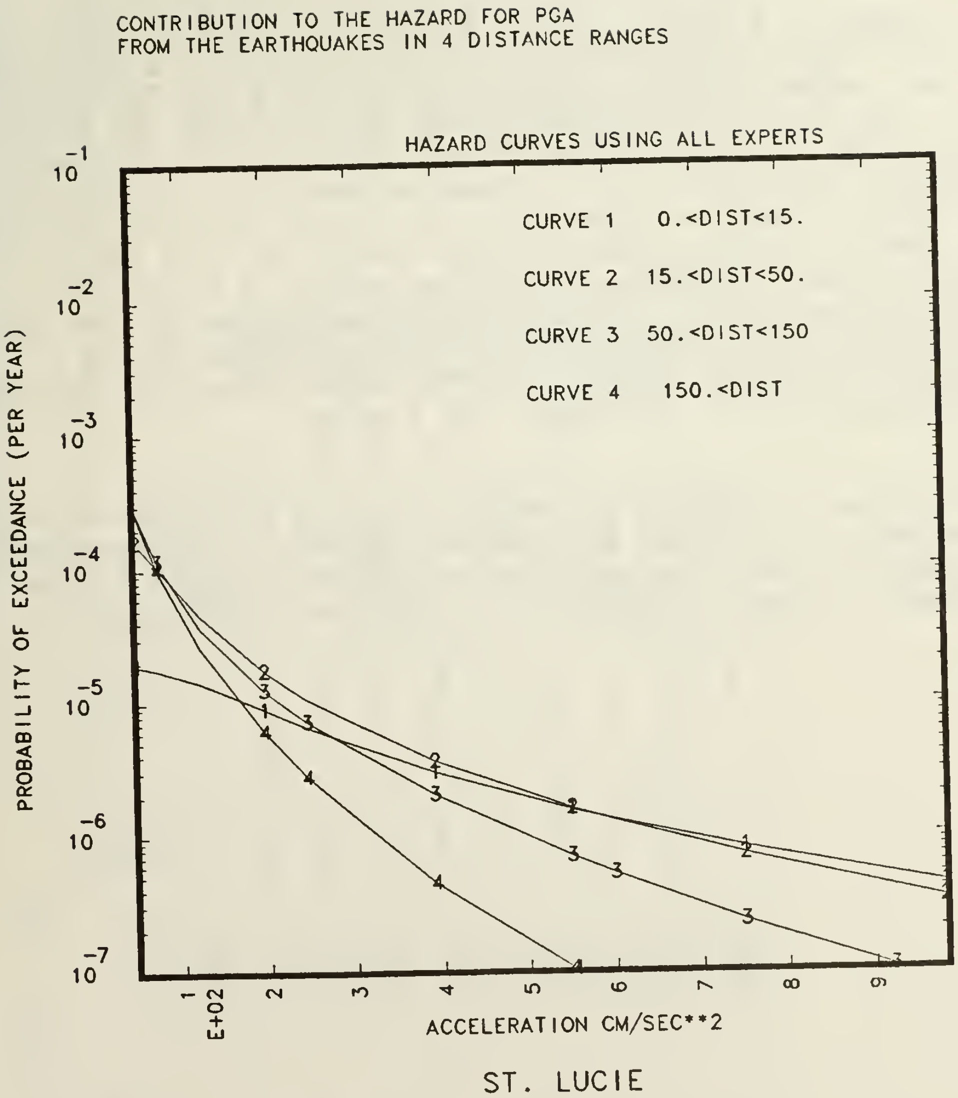

Figure 2.14.11 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated distance ranges for the St. Lucie site.

2.15 TURKEY POINT

Turkey Point is a rock site and is represented by the symbol "F" in Fig. 1.1. Table 2.15.1 and Figs. 2.15.1 to 2.15.10 give the results of the analysis for this site. The AMHC is higher than the 85th percentile by a factor of 5 to 6 and the BEHC is between the 50th and the 85th percentile. This indicates the presence of some outlier curves in the simulation. Table 2.15.1 shows that for most S-Experts, the Turkey Point site is located inside a complementary zone or an extended low seismicity zone or an extended low seismicity zone, with a relatively low upper magnitude cutoffs and low occurrence rates and these zones generally dominate the hazard.

S-Expert 12 (symbol "C") appears to be a low outlier in Fig. 2.15.2. This is because for this expert, the Turkey Point site is located in a zone (zone 26) which has a best estimate upper magnitude cutoff of 4.7 (see Table B12.1 in Appendix B). Thus the first zones which contribute anything are already distant enough that the ground motion at the site has been significantly attenuated, since the analysis only includes earthquakes of magnitude 5.0 and above. Fig. 2.15.4 shows that above 0.25g the largest contribution is from earthquakes greater than magnitude 6.5, with ranges 5.0 -5.75 and 5.75 - 6.5 contributing less and earthquakes of magnitude between 3.75 and 5.0 contributing only very little. Hence including earthquakes in that latter range for PGA values above 0.25g would not have changed the hazard significantly at this site. However, for PGA values below 0.25g, the total hazard is dominated by small earthquakes ($m_b < 5.0$).

The discussion given in Sections 2.1 and 2.3 relative to the dominance of G-Expert 5's GM model for the BEHC and AMHC also applies. The discussion given in Section 2.14 as to why large magnitude earthquakes dominate and that the hazard is primarily from the host zone also holds for this zone.

TABLE 2.15.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR TURKEY POINT

SITE SOIL CATEGORY ROCK

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 1	ZONE ID:	ZONE 1	ZONE 2	ZONE 3		ZONE 1	ZONE 2	ZONE 3	
		% CONT.:	96.	4.	0.	0.	100.	0.	0.	0.
2	COMP. ZO	ZONE ID:	ZONE 30	COMP. ZON	ZONE 29		COMP. ZON	ZONE 30	ZONE 29	
		% CONT.:	67.	33.	0.	0.	84.	16.	0.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 9	ZONE 8A	ZONE 8	COMP. ZON	ZONE 7	ZONE 9	ZONE 8
		% CONT.:	95.	5.	0.	0.	100.	0.	0.	0.
4	ZONE 25	ZONE ID:	ZONE 25	ZONE 10	COMP. ZON	ZONE 9	ZONE 25	COMP. ZON	ZONE 9	ZONE 10
		% CONT.:	56.	42.	2.	0.	99.	1.	0.	0.
5	ZONE 21	ZONE ID:	ZONE 9	ZONE 21	COMP. ZON	ZONE 10	ZONE 9	ZONE 21	COMP. ZON	ZONE 8
		% CONT.:	88.	11.	1.	0.	63.	35.	2.	0.
6	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 13	ZONE 16	ZONE 14	COMP. ZON	ZONE 13	ZONE 14	ZONE 16
		% CONT.:	73.	27.	0.	0.	97.	3.	0.	0.
7	ZONE 1	ZONE ID:	ZONE 10	ZONE 1	ZONE 2 =	ZONE 8	ZONE 1	ZONE 2 =	ZONE 10	ZONE 8
		% CONT.:	54.	33.	13.	0.	76.	12.	12.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 15	ZONE 4B	ZONE 28	ZONE 19 =	ZONE 15	ZONE 4B	ZONE 28
		% CONT.:	99.	1.	0.	0.	100.	0.	0.	0.
11	ZONE 8	ZONE ID:	ZONE 8	CZ = ZONE	ZONE 7	ZONE 14	ZONE 8	CZ = ZONE	ZONE 7	ZONE 14
		% CONT.:	76.	24.	0.	0.	95.	5.	0.	0.
12	ZONE 26	ZONE ID:	ZONE 23A	ZONE 24	ZONE 23	ZONE 25	ZONE 23A	ZONE 22	ZONE 23	ZONE 24
		% CONT.:	99.	0.	0.	0.	100.	0.	0.	0.
13	CZ 16	ZONE ID:	CZ 16	ZONE 9	CZ 18	CZ 15	CZ 16	CZ 15	CZ 18	ZONE 9
		% CONT.:	81.	13.	4.	2.	89.	11.	0.	0.

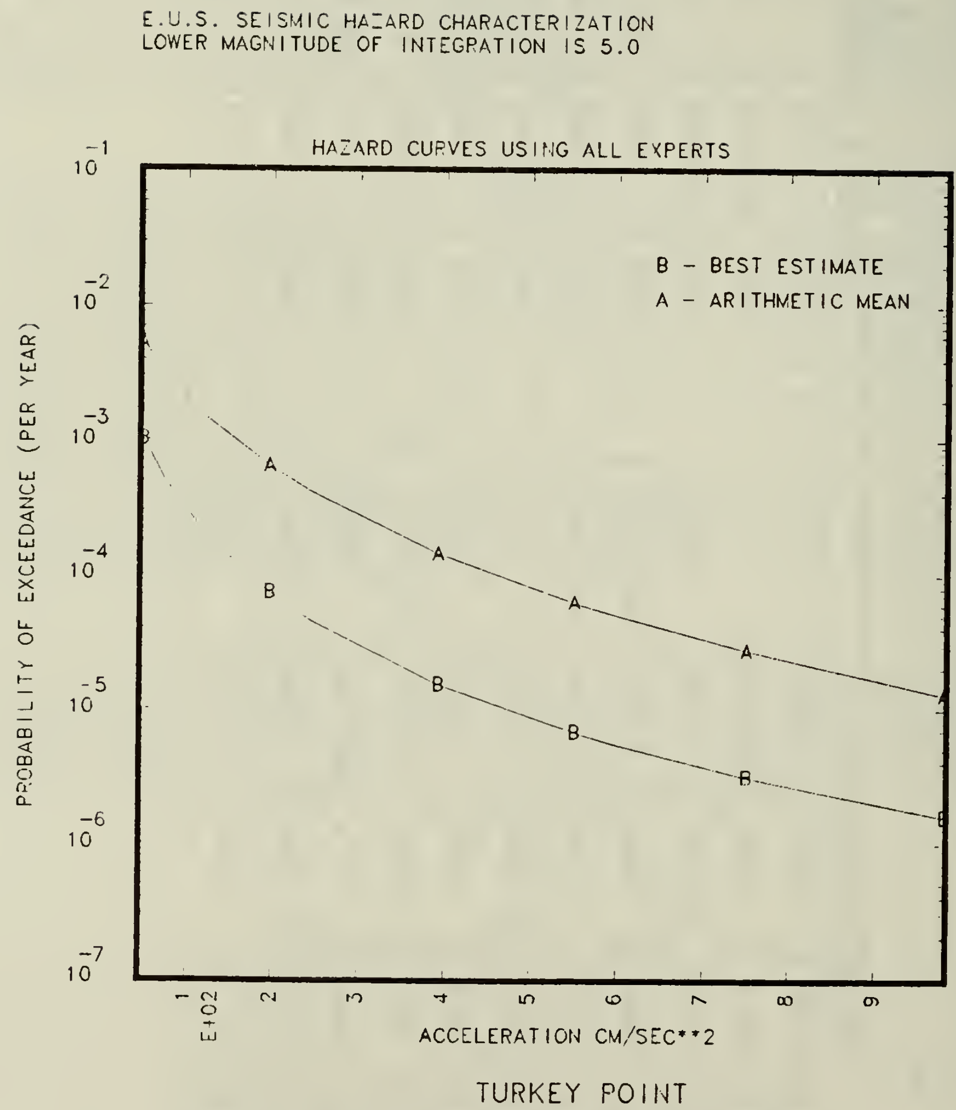

Figure 2.15.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Turkey Point site.

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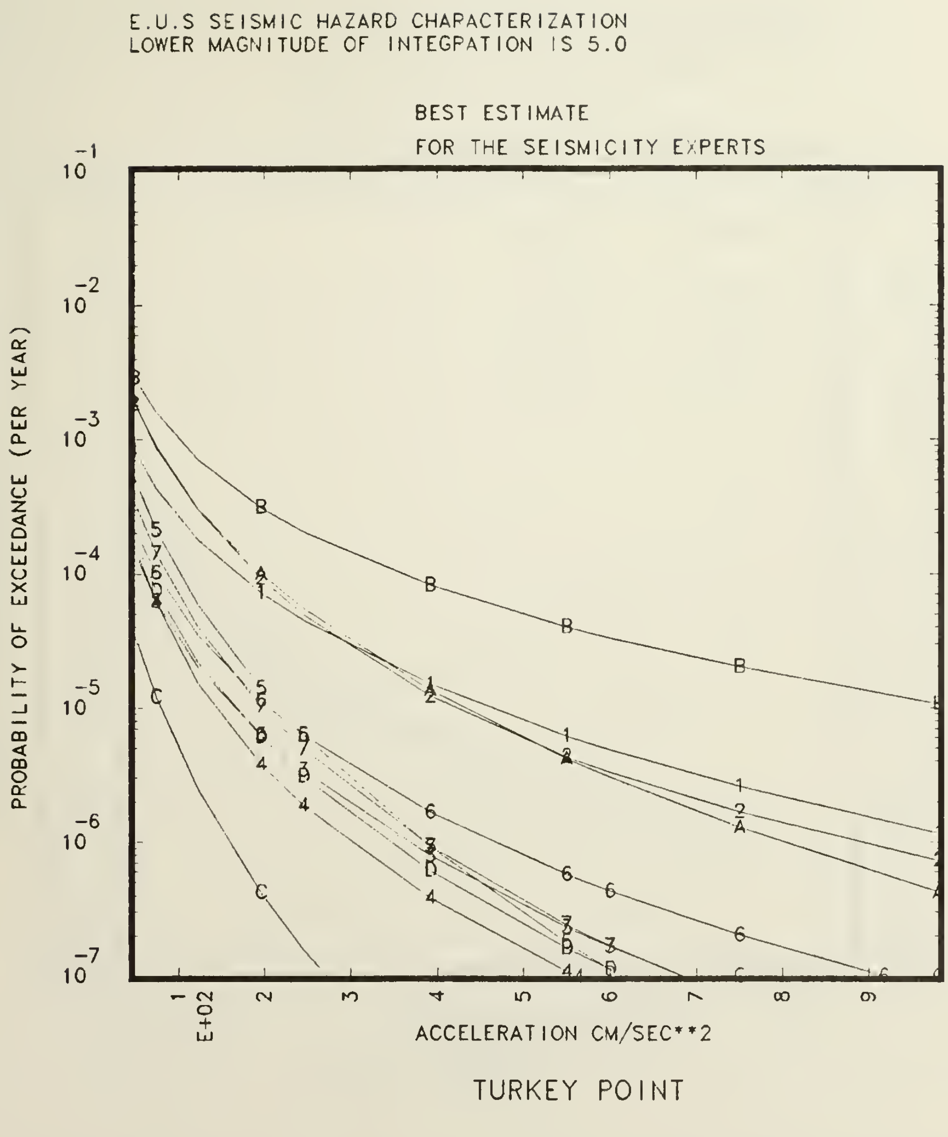

Figure 2.15.2 BEHCs per S-Expert combined over all G-Experts for the Turkey Point site. Plot symbols given in Table 2.0.

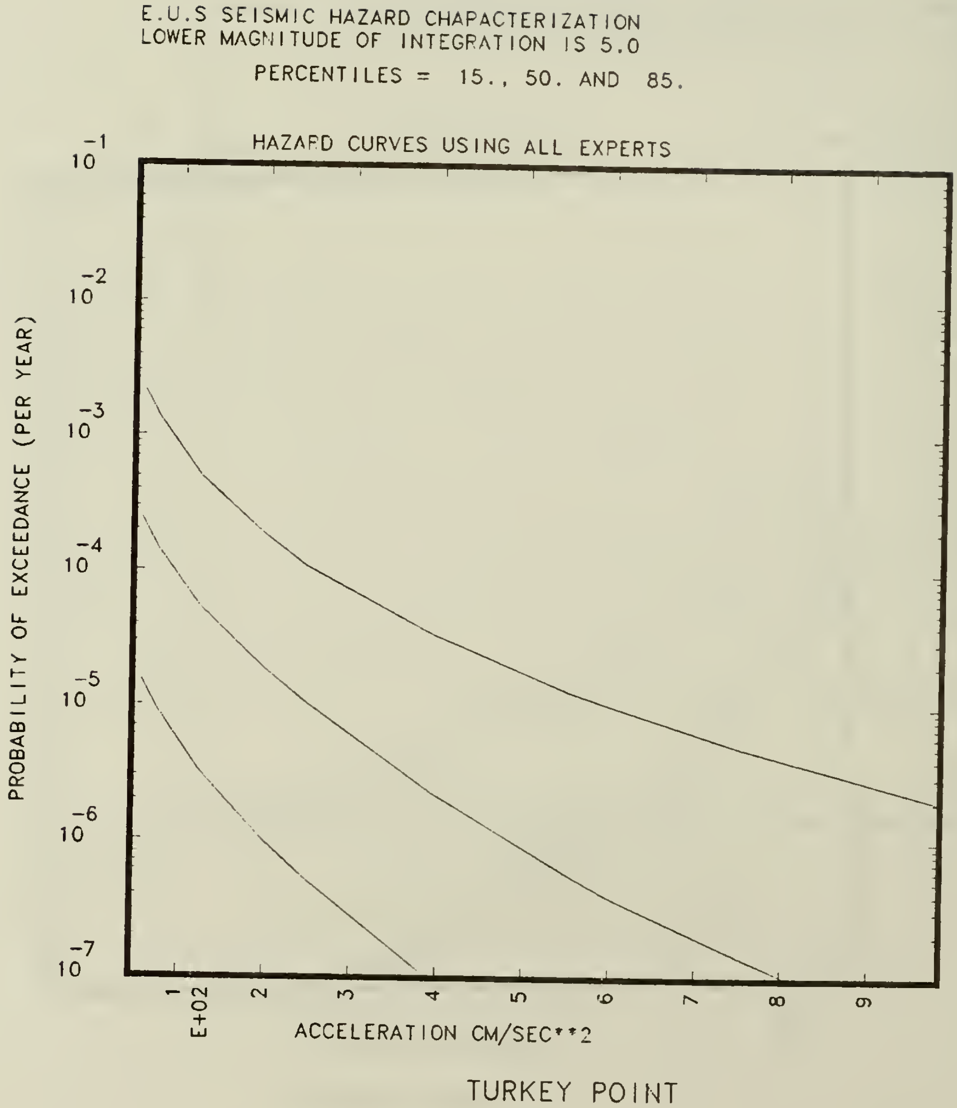

Figure 2.15.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Turkey Point site.

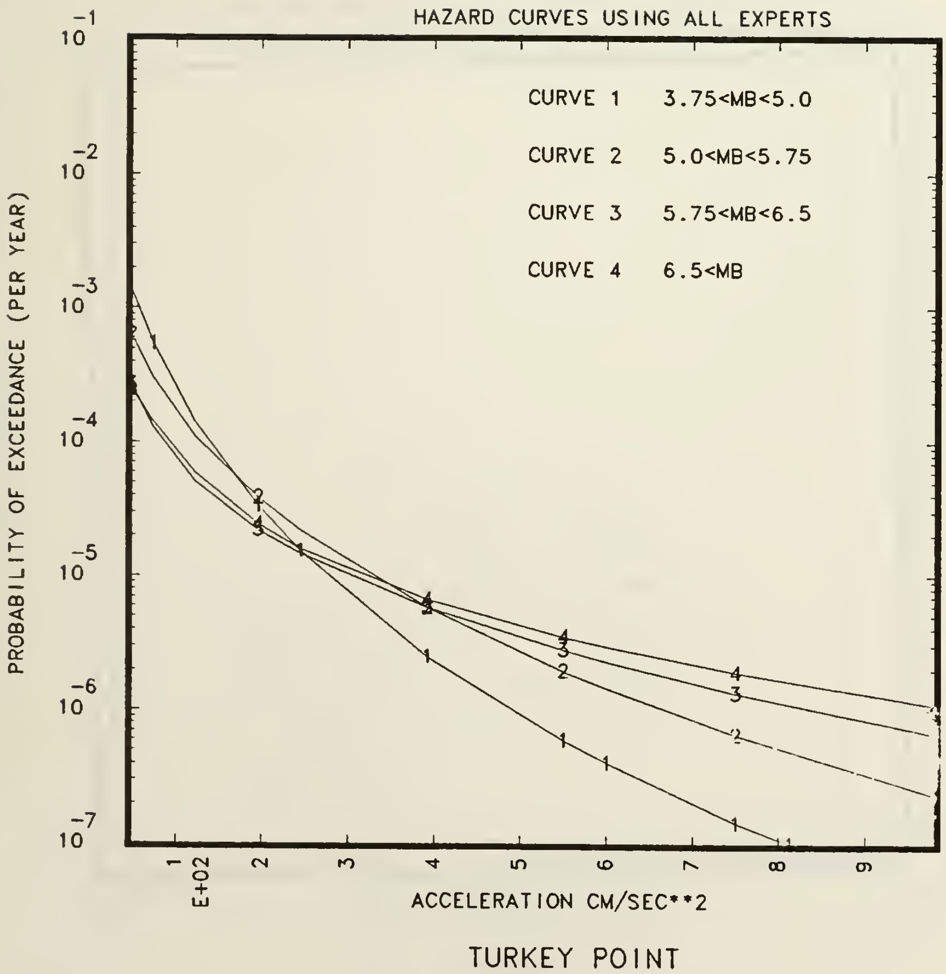

Figure 2.15.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Turkey Point site.

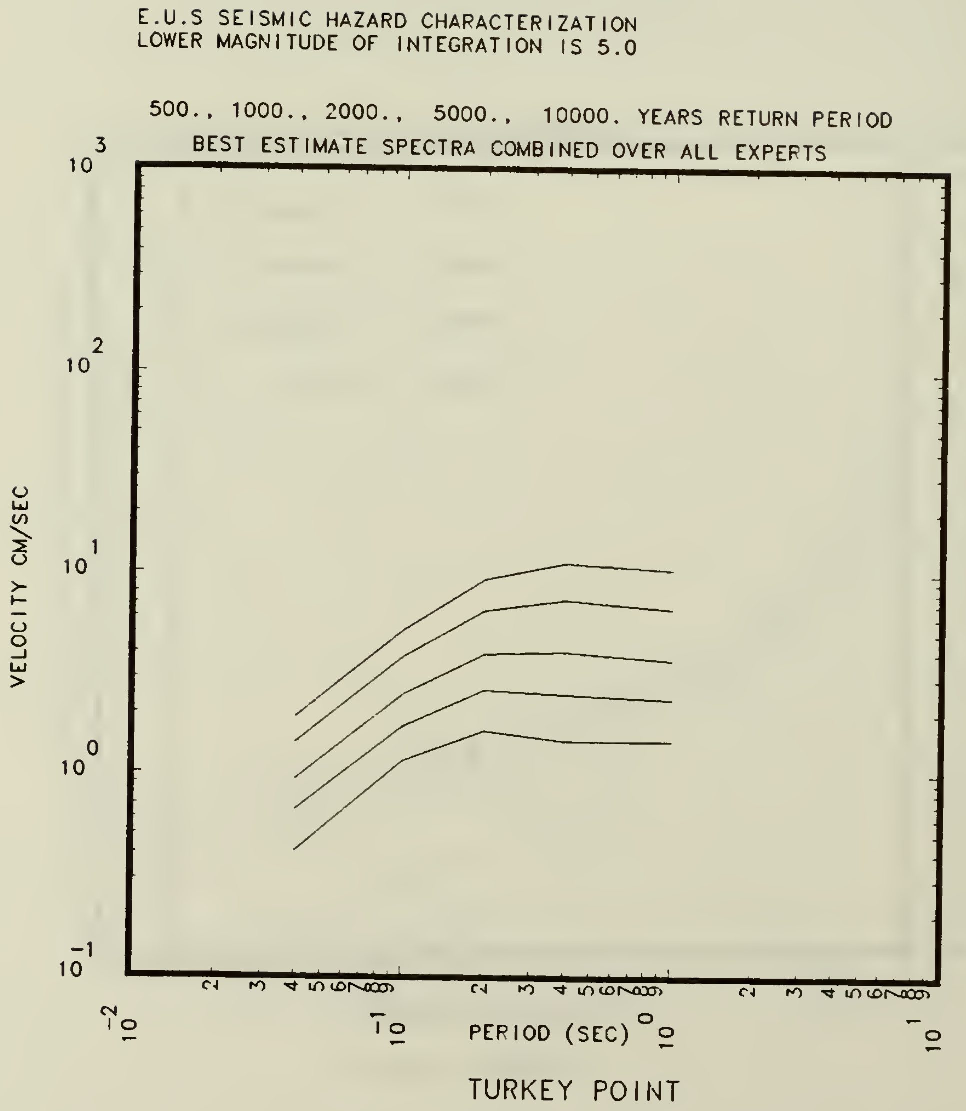

Figure 2.15.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Turkey Point site.

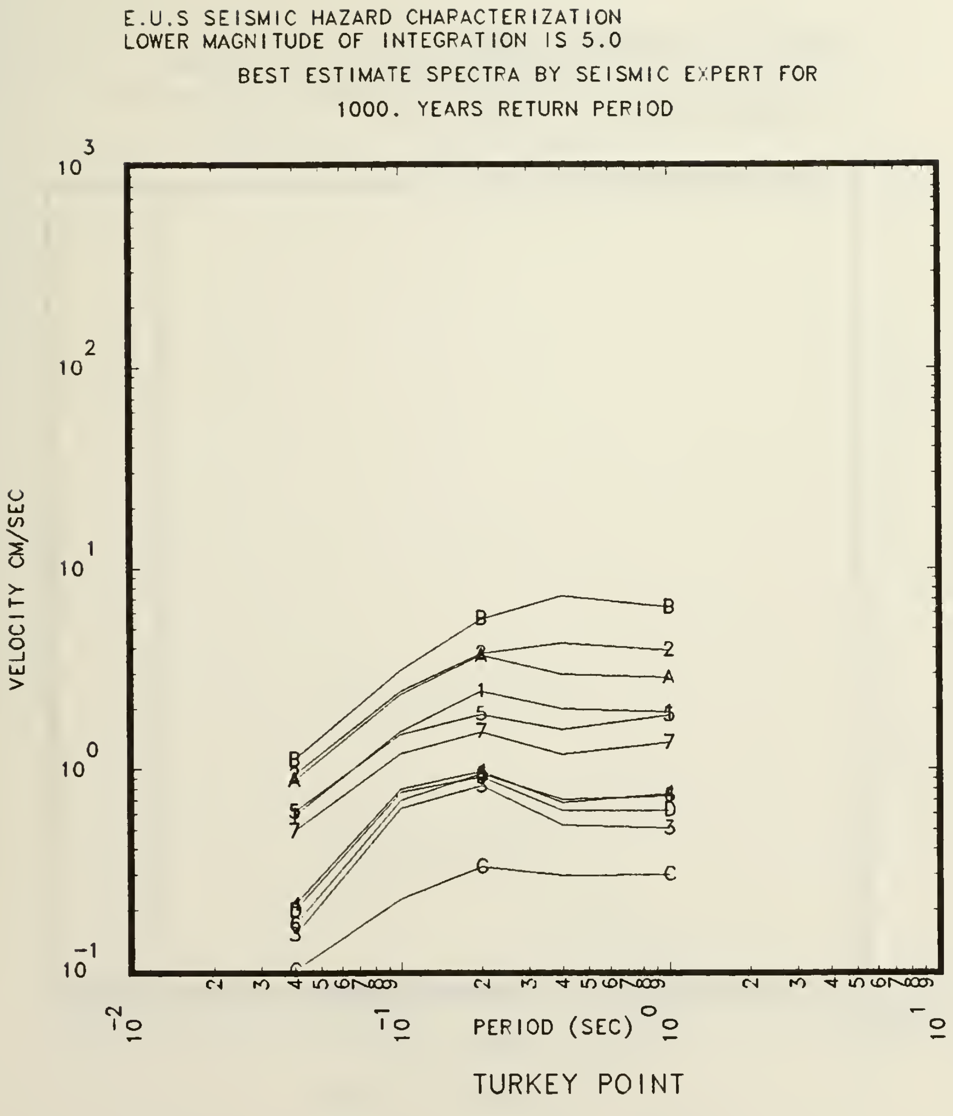

Figure 2.15.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Turkey Point site. Plot symbols are given in Table 2.0.

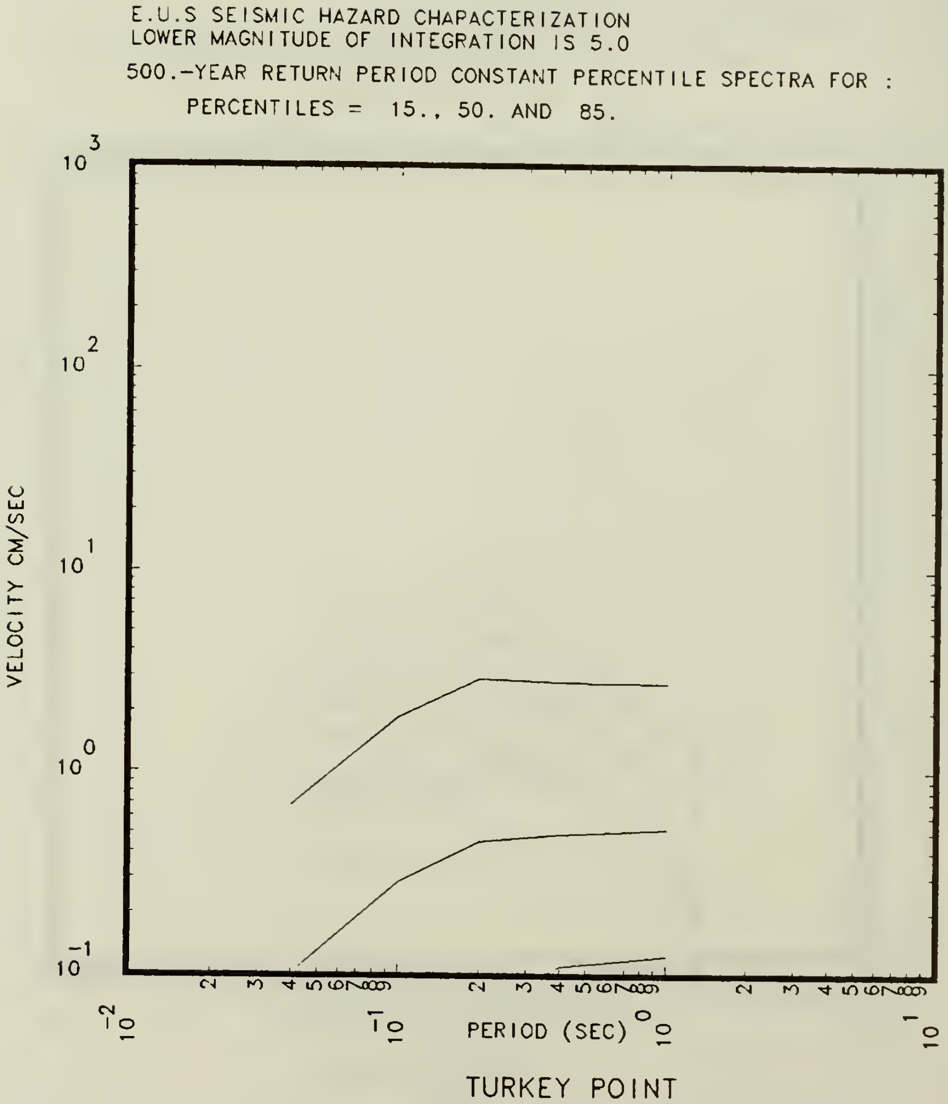

Figure 2.15.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Turkey Point site.

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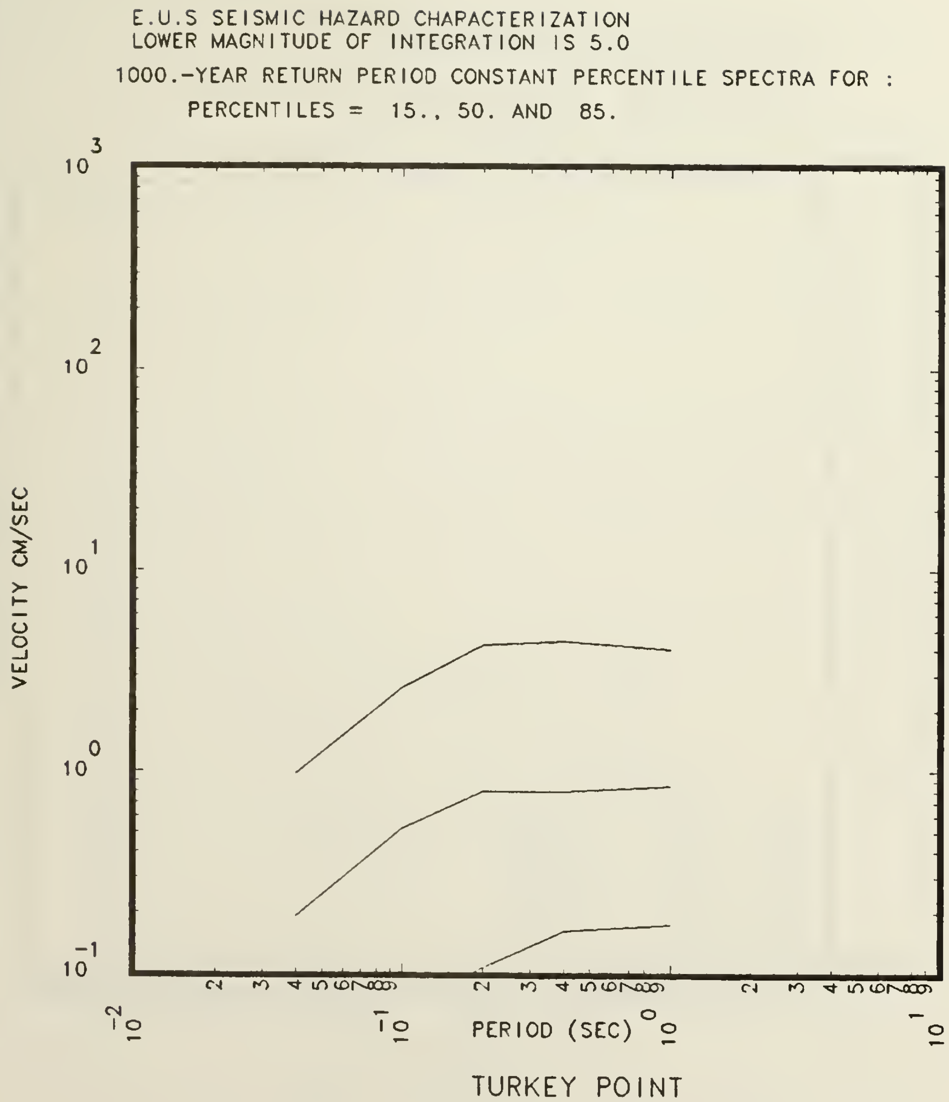

Figure 2.15.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Turkey Point site.

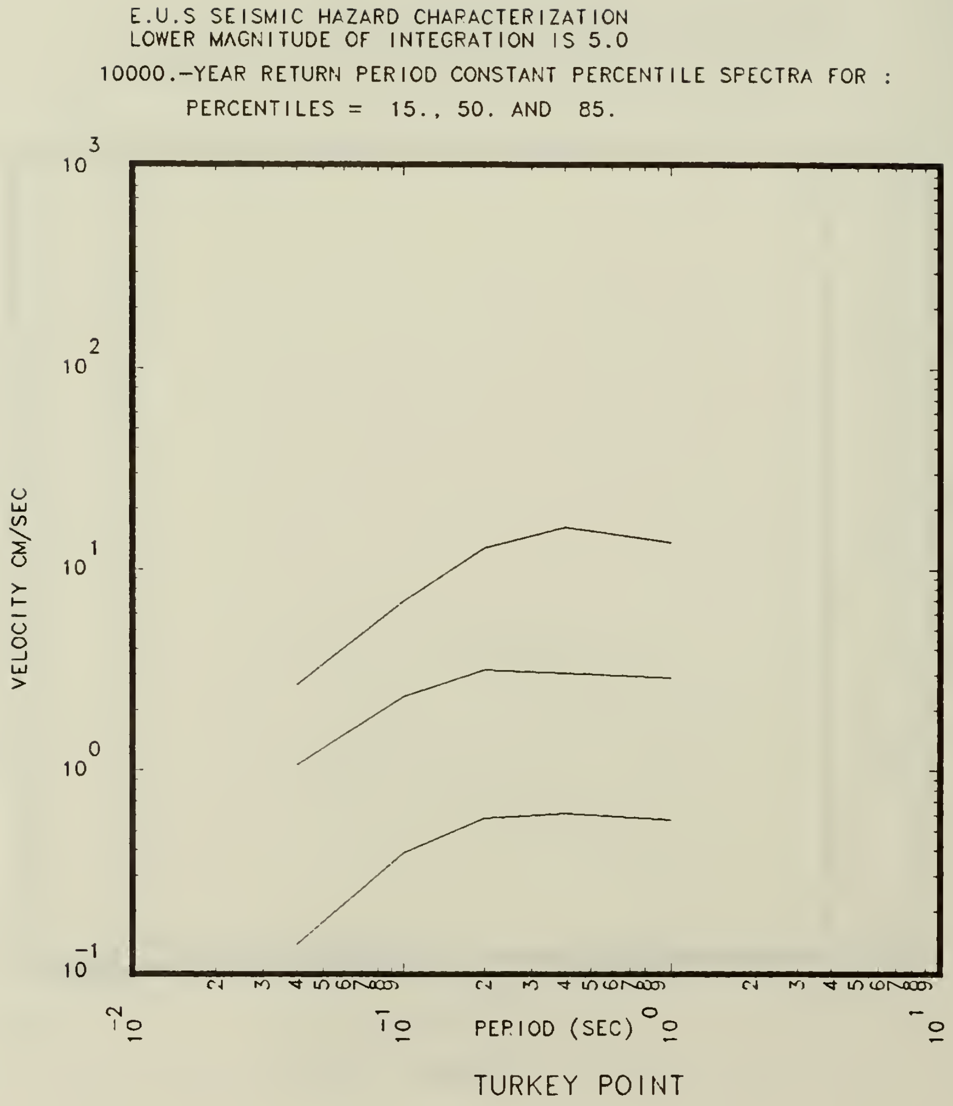

Figure 2.15.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Turkey Point site.

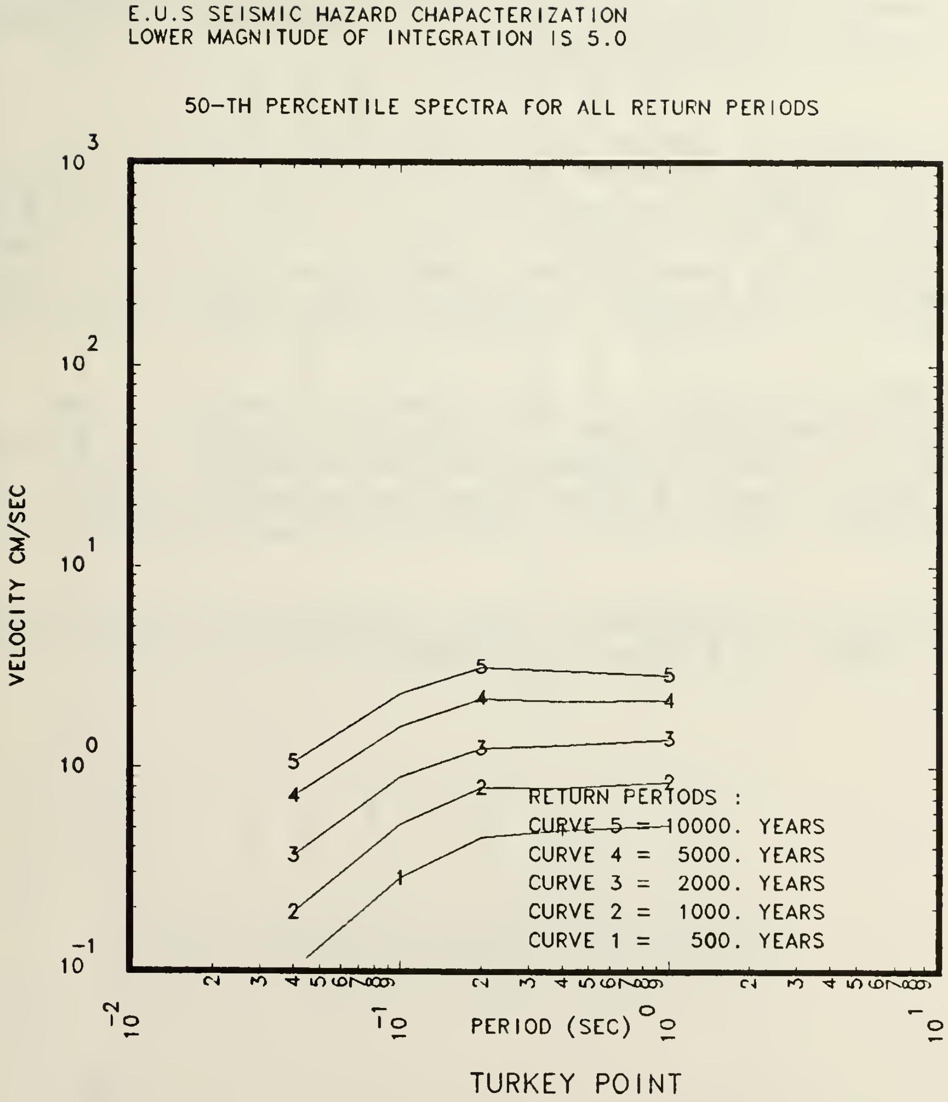

Figure 2.15.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Turkey Point site.

2.16 WATERFORD

Waterford is a deep soil site and is represented by the symbol "G" in Fig. 1.1. Table 2.16.1 and Figs. 2.16.1 to 2.16.10 give the results of the analysis for this site. The AMHC is higher than the 85th percentile by a factor of 5 to 20 and the BEHC is between the 50th and the 85th percentile. This indicates the presence of both high and low outlier curves in the simulation. Table 2.16.1 shows that for most S-Experts, the Waterford site is located inside a complementary zone or an extended low seismicity zone, with a relatively low upper magnitude cutoffs and low occurrence rates. The main difference in the hazard estimate between the River Bend site and the Waterford site is that the AMHC is much higher at Waterford than at River Bend. This is because the Waterford site is in S-Expert 5's zone 11. S-Expert 5's zone 11 introduced the high outliers which led to the high relative level for the AMHC at the Waterford site.

S-Expert 12 (symbol "C") appears to be a low outlier in Fig. 2.16.2. This is because for this expert, the Waterford site is located in a zone (zone 10) which has a best estimate upper magnitude cutoff of 5.0 (see Table B12.1 in Appendix B), thus the first zones which contribute anything are already distant enough that the ground motion at the site be significantly attenuated, since the analysis only includes earthquakes of magnitude 5.0 and above.

Fig. 2.16.4 shows that above 0.55g the largest contribution is from earthquakes in the magnitude range of 5.75 to 6.5. However, in the range of 0.05g to about 0.25g small earthquakes are most important. Thus, if earthquakes in the range of 3.75 to 5. had been included, the hazard would have been increased significantly in the 0.05 to about 0.4g range.

The discussion given in Sections 2.1 and 2.8 relative to the spread between the G-Experts' BEHCs per S-Expert also holds for this site.

TABLE 2.16.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR WATERFORD

SITE SOIL CATEGORY DEEP-SOIL

S-XPT NUM.	HOST ZONE		ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 1	ZONE ID:	ZONE 1	ZONE 9	ZONE 10	ZONE 5	ZONE 1	ZONE 9	ZONE 5	ZONE 3
		% CONT.:	71.	25.	2.	1.	93.	7.	0.	0.
2	COMP. ZO	ZONE ID:	ZONE 18	COMP. ZON	ZONE 27	ZONE 20	COMP. ZON	ZONE 18	ZONE 1	ZONE 2
		% CONT.:	78.	22.	0.	0.	52.	48.	0.	0.
3	COMP. ZO	ZONE ID:	COMP. ZON	ZONE 13	ZONE 8A	ZONE 12	COMP. ZON	ZONE 13	ZONE 8A	ZONE 5
		% CONT.:	85.	10.	2.	1.	99.	1.	0.	0.
4	ZONE 25	ZONE ID:	ZONE 4	ZONE 25	ZONE 8	ZONE 3	ZONE 4	ZONE 25	COMP. ZON	ZONE 1
		% CONT.:	95.	5.	0.	0.	89.	10.	1.	0.
5	ZONE 11	ZONE ID:	ZONE 11	ZONE 15	COMP. ZON	ZONE 10	ZONE 11	ZONE 15	COMP. ZON	ZONE 8
		% CONT.:	90.	10.	0.	0.	96.	4.	0.	0.
6	ZONE 21	ZONE ID:	ZONE 21	ZONE 18	ZONE 17	COMP. ZON	ZONE 21	COMP. ZON	ZONE 18	ZONE 17
		% CONT.:	86.	7.	4.	1.	98.	1.	0.	0.
7	ZONE 1	ZONE ID:	ZONE 6	ZONE 1	ZONE 2 =	ZONE 5	ZONE 6	ZONE 1	ZONE 2 =	ZONE 5
		% CONT.:	89.	9.	1.	1.	85.	15.	1.	0.
10	ZONE 19	ZONE ID:	ZONE 19 =	ZONE 12A	ZONE 28	ZONE 29	ZONE 19 =	ZONE 4B	ZONE 12A	ZONE 13
		% CONT.:	98.	2.	0.	0.	100.	0.	0.	0.
11	ZONE 14	ZONE ID:	ZONE 14	ZONE 11	ZONE 8	CZ = ZONE	ZONE 14	CZ = ZONE	ZONE 8	ZONE 11
		% CONT.:	66.	15.	13.	3.	84.	13.	2.	1.
12	ZONE 10	ZONE ID:	ZONE 15	ZONE 14	ZONE 3	ZONE 11	ZONE 15	ZONE 3	ZONE 6	ZONE 8
		% CONT.:	74.	11.	10.	2.	99.	1.	0.	0.
13	CZ 16	ZONE ID:	CZ 16	ZONE 5	CZ 15	ZONE 8	CZ 16	CZ 15	ZONE 5	ZONE 1
		% CONT.:	55.	40.	5.	0.	52.	37.	11.	0.

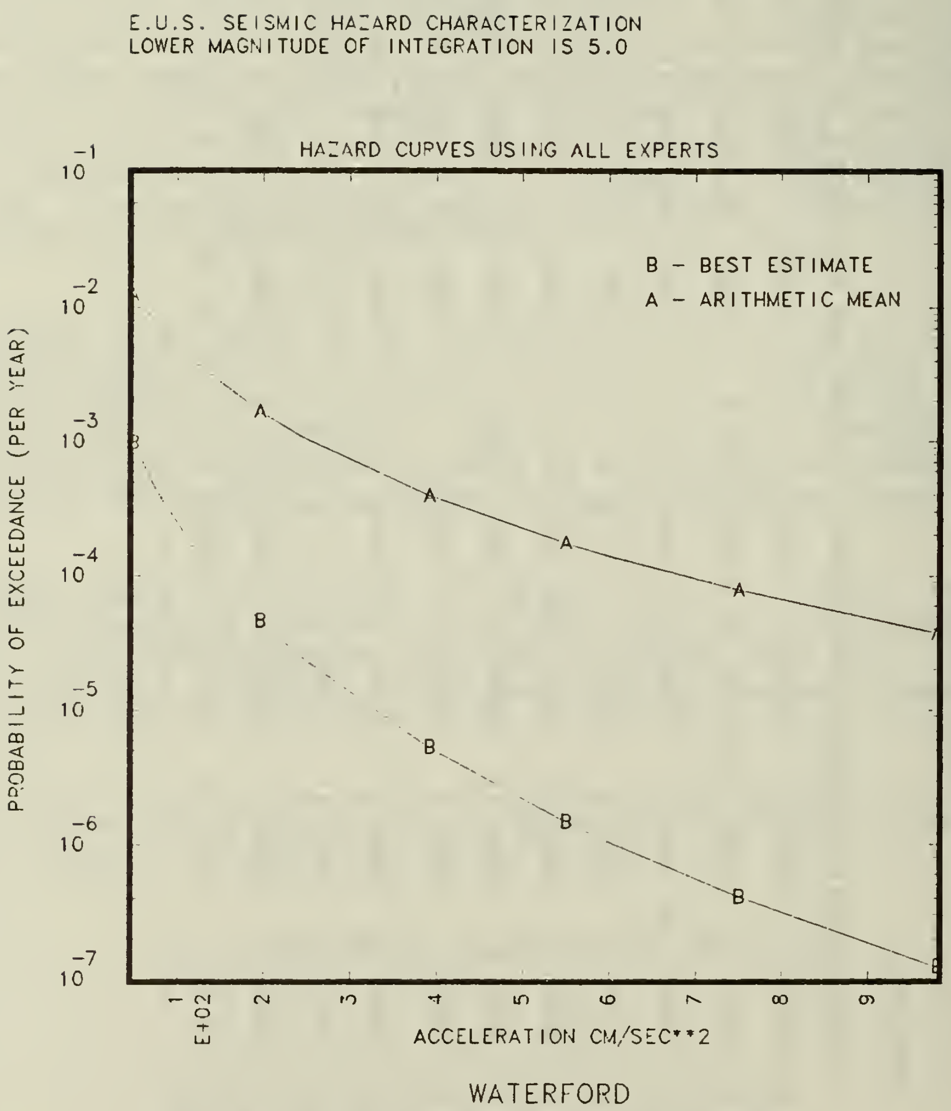

Figure 2.16.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Waterford site.

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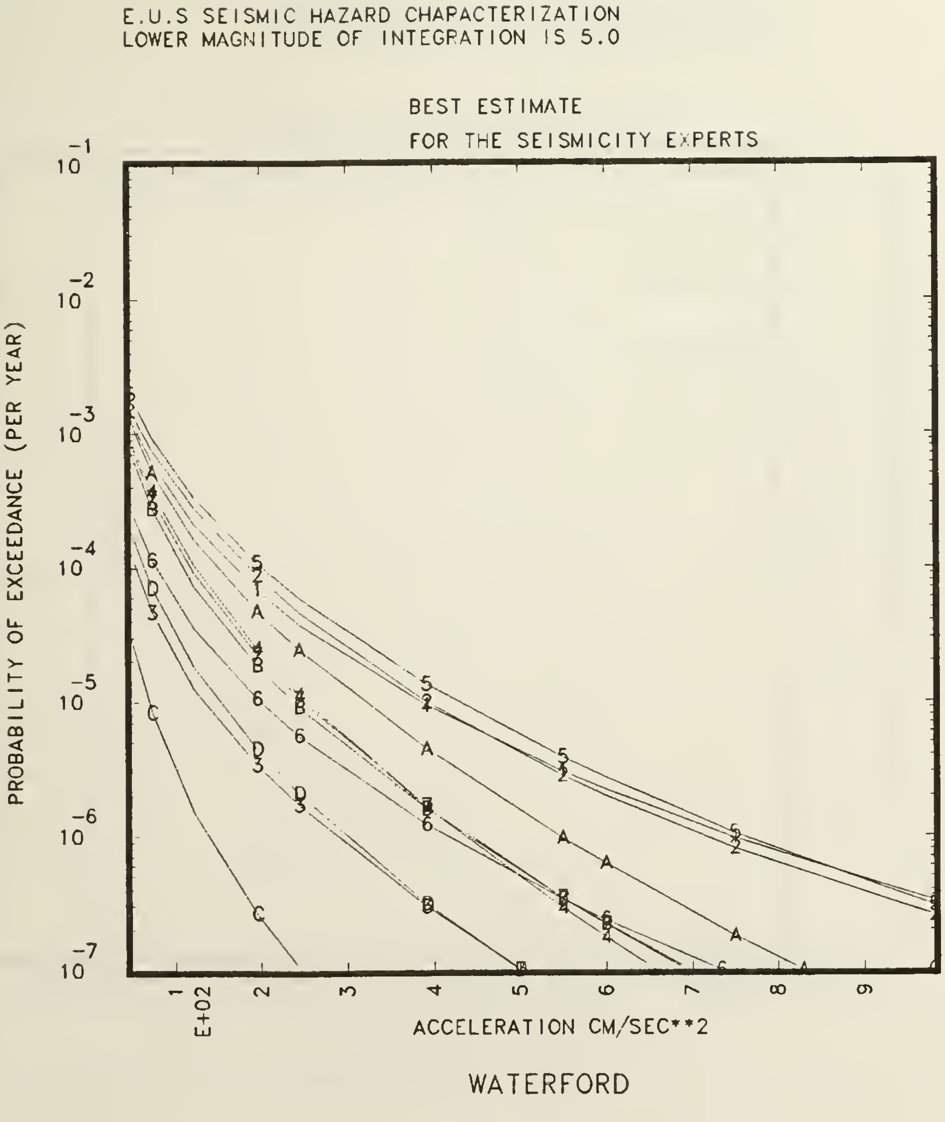

Figure 2.16.2 BEHCs per S-Expert combined over all G-Experts for the Waterford site. Plot symbols given in Table 2.0.

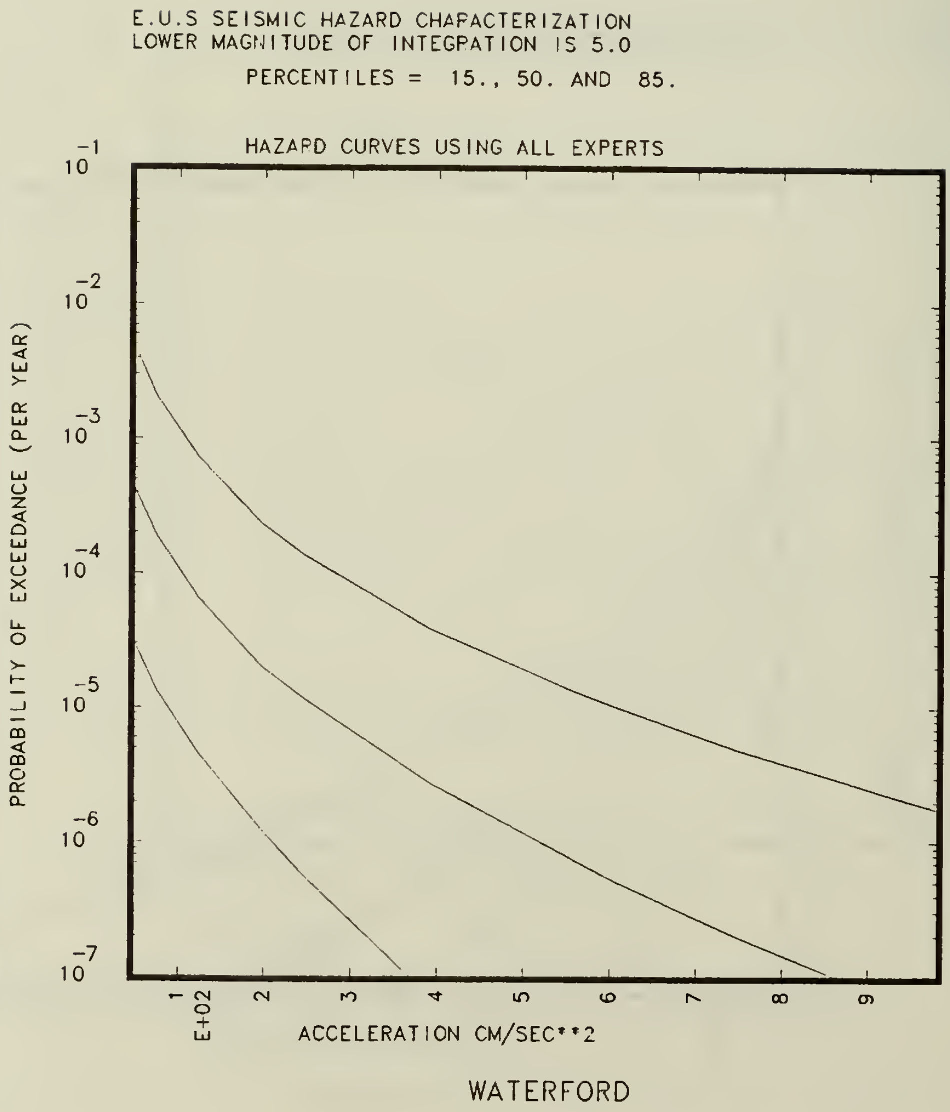

Figure 2.16.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Waterford site.

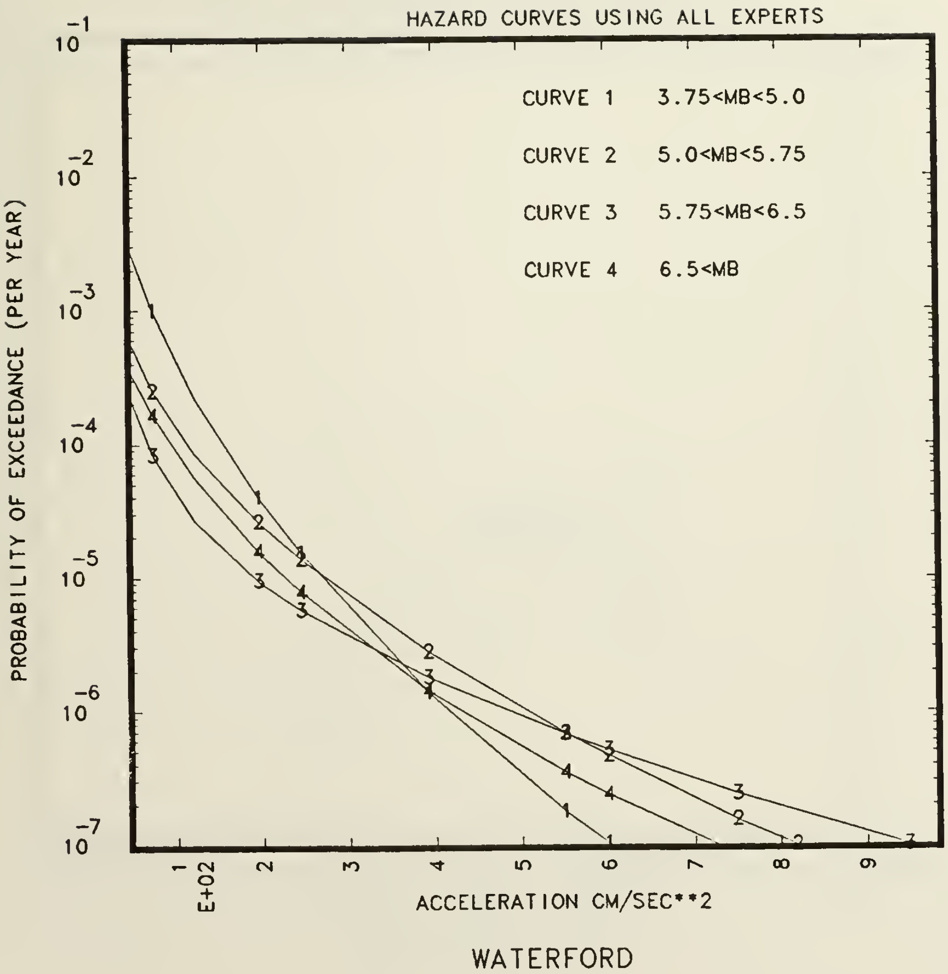

Figure 2.16.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Waterford site.

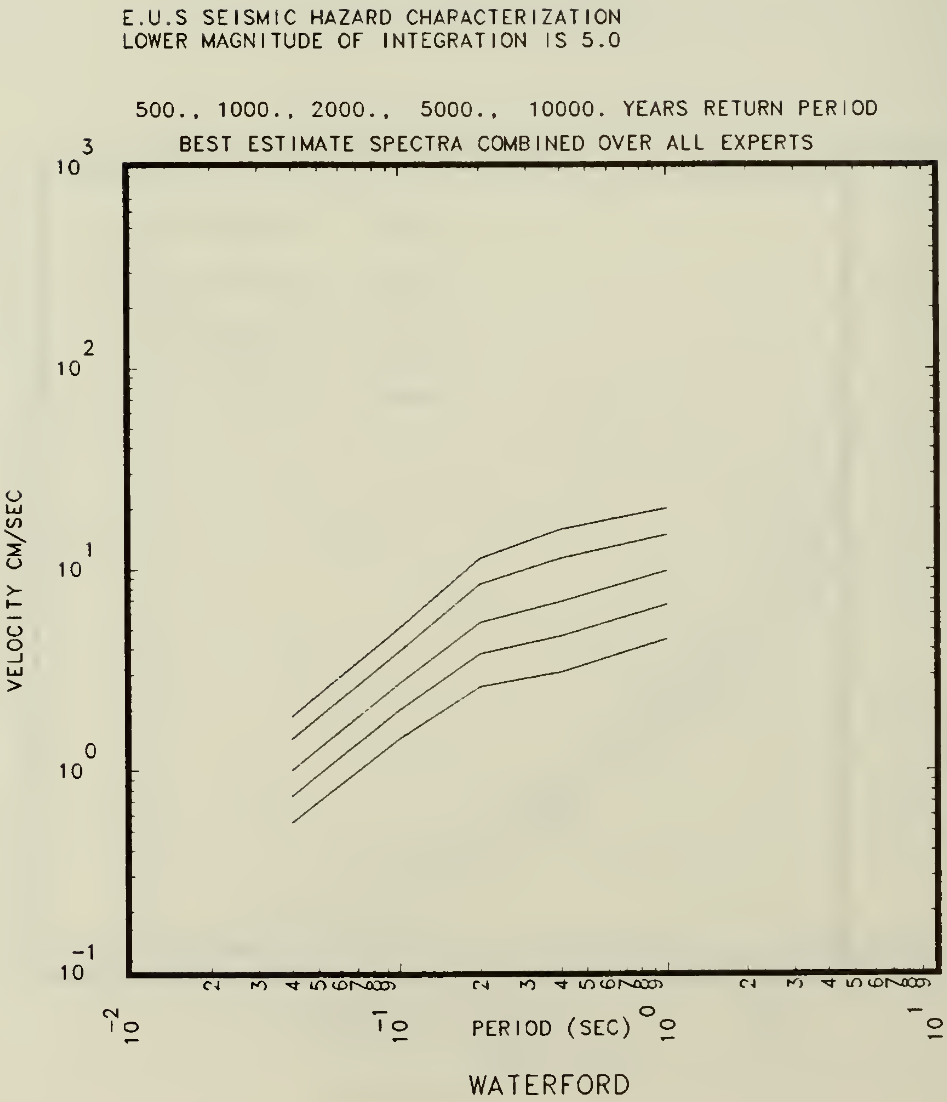

Figure 2.16.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Waterford site.

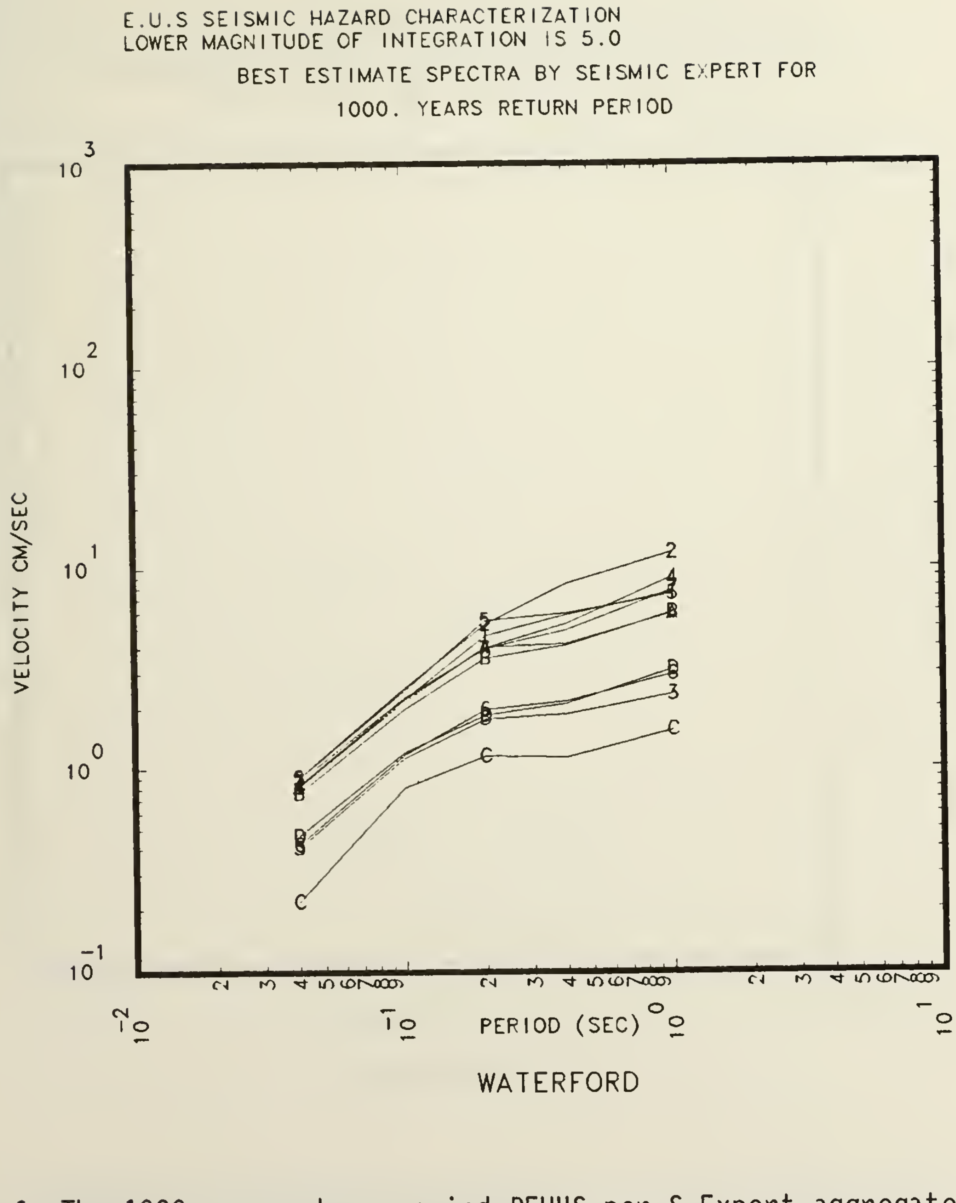

Figure 2.16.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Waterford site. Plot symbols are given in Table 2.0.

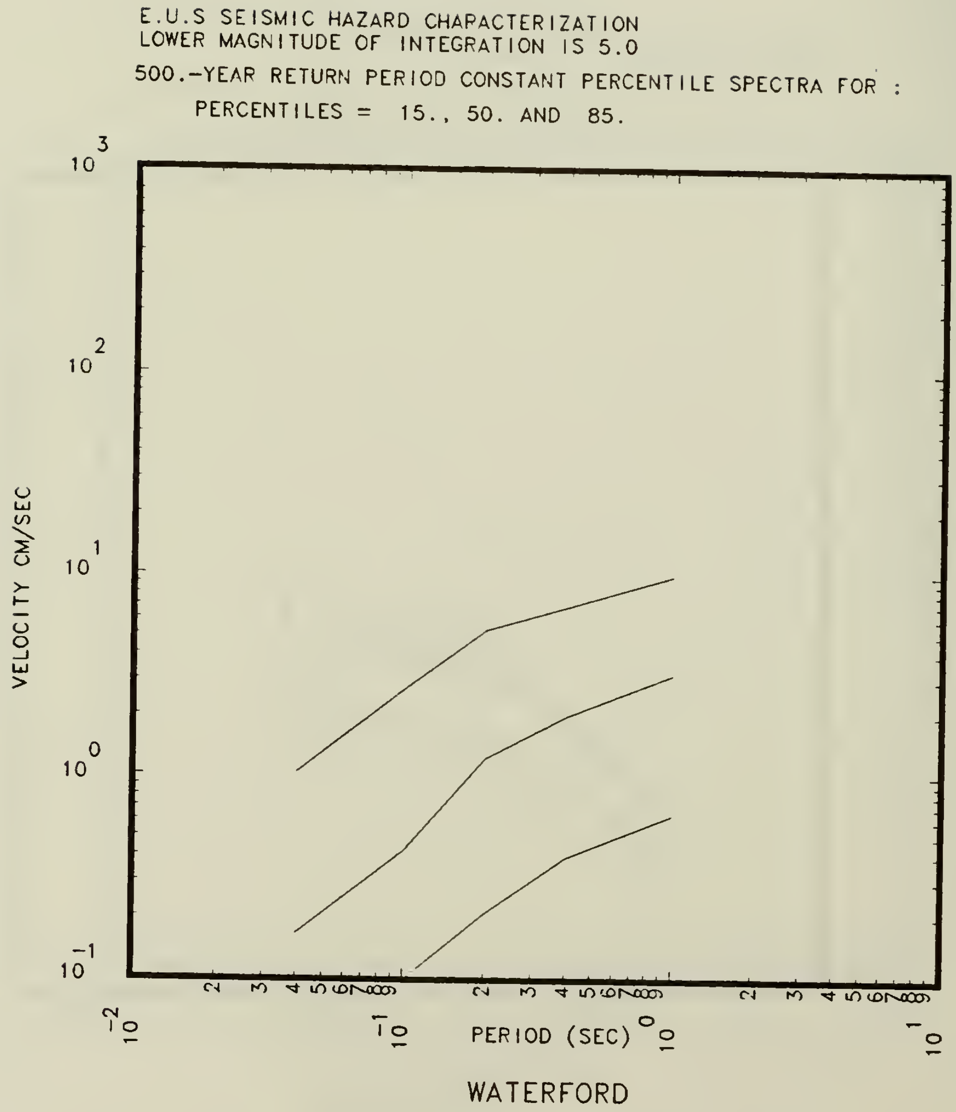

Figure 2.16.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Waterford site.

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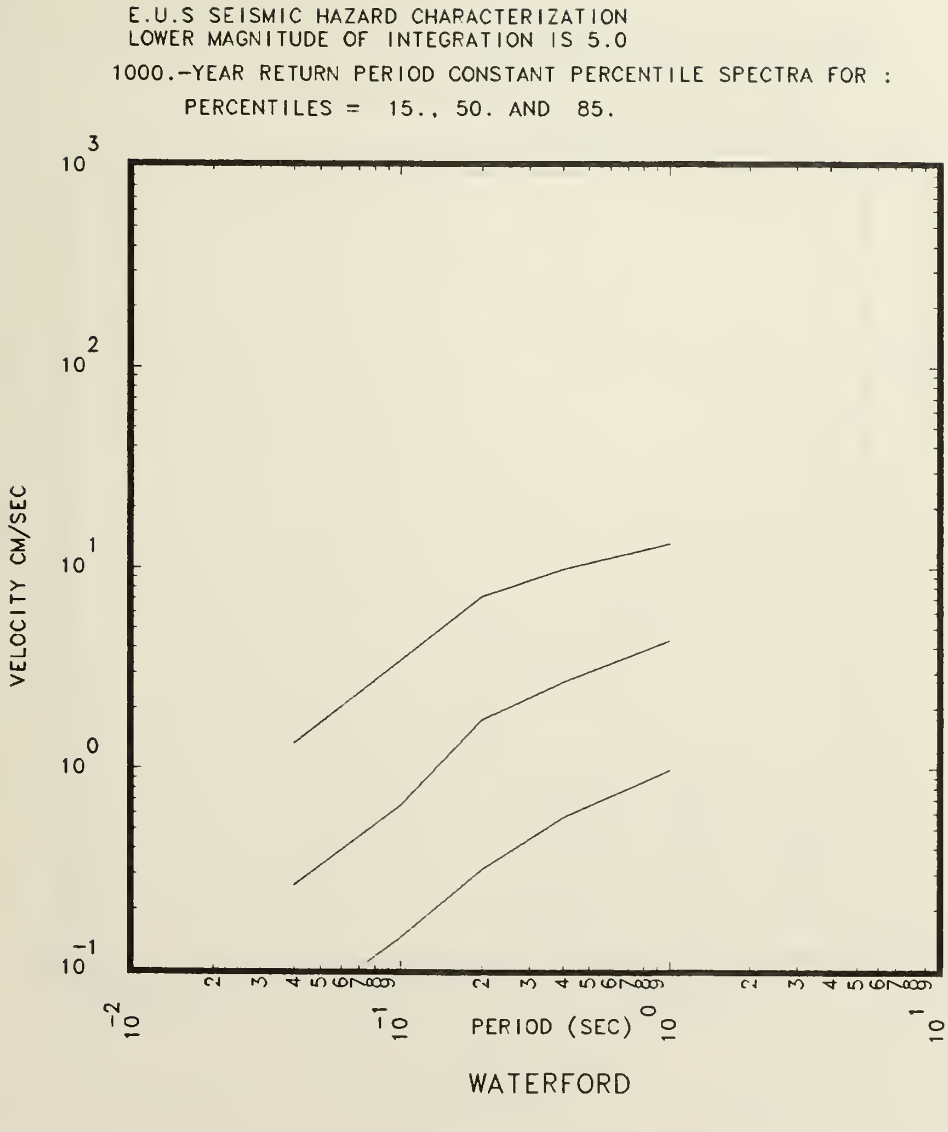

Figure 2.16.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Waterford site.

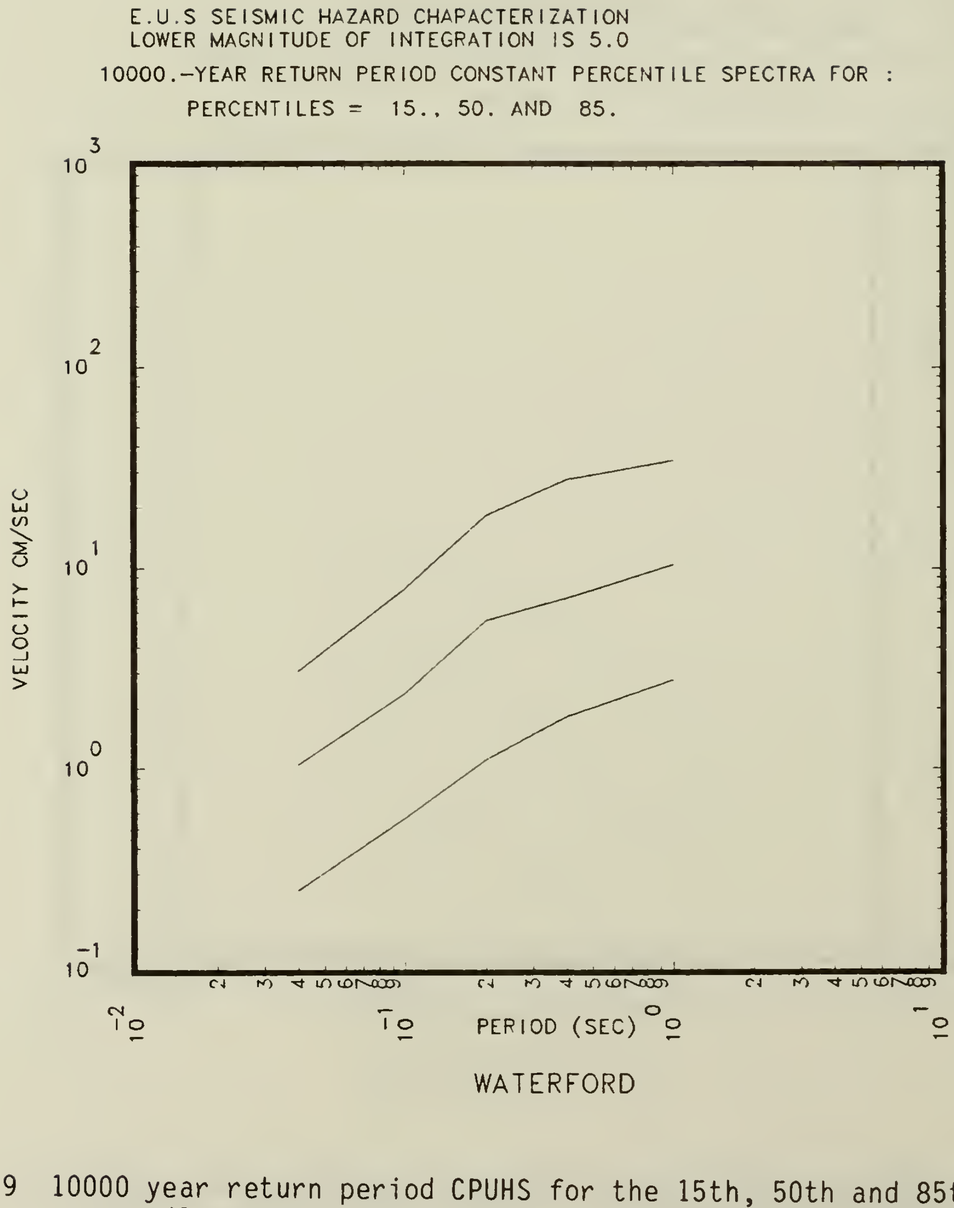

Figure 2.16.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Waterford site.

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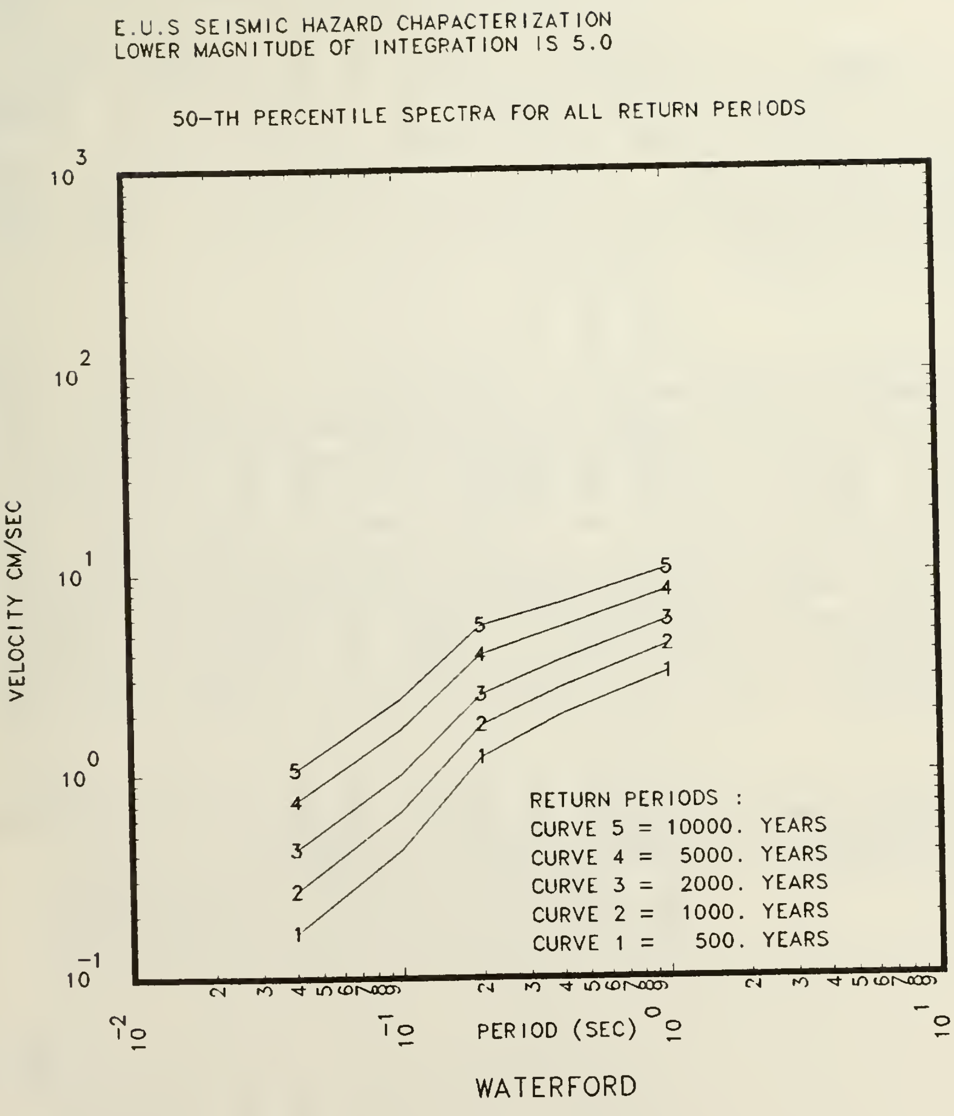


Figure 2.16.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Waterford site.

2.17 WOLF CREEK

Wolf Creek is a rock site and is represented by the symbol "H" in Fig. 1.1. Table 2.17.1 and Figs. 2.17.1 to 2.17.10 give the results of the analysis for this site. The AMHC is higher than the 85th percentile and the BEHC is between the 50th and the 85th percentile. This indicates the presence of some outlier curves in the simulation. Table 2.17.1 shows that for most S-Experts, (8), the Wolf Creek site is located inside a complementary zone, with relatively low upper magnitude cutoffs and low occurrence rates. However, the Wolf Creek site is sufficiently far from the New Madrid region that the New Madrid region only dominates for 5 of the S-Experts. For the other S-Experts, zones closer to the site than the New Madrid zones dominate the hazard.

S-Expert 12 (symbol "C") appears to be a low outlier in Fig. 2.17.2. This is because for this expert, the Wolf Creek site is located in the complementary zone (zone 4) which has a best estimate upper magnitude cutoff of 5.0 (see Table B12.1 in Appendix B). Thus the first zones which contribute anything are already distant enough that the ground motion at the site has been significantly attenuated, since the analysis only includes earthquakes of magnitude 5.0 and above.

Fig. 2.17.4 shows that the biggest contribution is from earthquakes greater than magnitude 6.5, with ranges 5.0 -5.75 and 5.75 - 6.5 contributing less and earthquakes of magnitude between 3.75 and 5.0 contributing only very little except for PGA values less than 0.1g where the small earthquakes dominate the total hazard. Hence including earthquakes in the 3.75 to 5.0 range for PGA values greater than 0.1g would not have changed the hazard significantly at this site but it would increase it by approximately 50% for PGA values less than 0.1g. One reason why large earthquakes so dominate the hazard at the Wolf Creek site, even though it is relatively far from the New Madrid region, is because S-Expert 2's input leads to a BEHC for PGA that is significantly higher than for the other S-Experts and S-Expert 2's BEHC is dominated by the New Madrid region.

The discussions given in Sections 2.1 and 2.3 relative to the dominance of G-Expert 5's GM model for the BEHC and AMHC also applies.

TABLE 2.17.1

MOST IMPORTANT ZONES PER S-EXPERT
FOR WOLF CREEK

SITE SOIL CATEGORY ROCK

S-XPT NUM.	HOST ZONE		Low PGA (0.125G) 1	Low 2	Low 3	Low 4	High PGA (0.60G) 1	High 2	High 3	High 4
			ZONES CONTRIBUTING MOST SIGNIFICANTLY TO THE PGA BEHC AND % OF CONTRIBUTION AT LOW PGA(0.125G)				AT HIGH PGA(0.60G)			
1	ZONE 15	ZONE ID:	ZONE 9	ZONE 10	ZONE 5	ZONE 14	ZONE 9	ZONE 10	ZONE 15	ZONE 5
		% CONT.:	44.	27.	11.	7.	74.	18.	4.	2.
2	ZONE 15	ZONE ID:	ZONE 18	ZONE 15	ZONE 5	COMP. ZON	ZONE 18	ZONE 15	COMP. ZON	ZONE 1
		% CONT.:	67.	19.	6.	4.	81.	15.	3.	0.
3	ZONE 16	ZONE ID:	ZONE 16	ZONE 13	ZONE 12	ZONE 14	ZONE 16	ZONE 13	ZONE 12	ZONE 14
		% CONT.:	64.	15.	12.	9.	94.	5.	1.	0.
4	ZONE 13	ZONE ID:	ZONE 4	ZONE 1	ZONE 3	ZONE 5	ZONE 4	ZONE 1	ZONE 13	ZONE 3
		% CONT.:	67.	27.	3.	2.	76.	23.	1.	0.
5	COMP. ZO	ZONE ID:	ZONE 15	ZONE 17	ZONE 14	COMP. ZON	ZONE 15	COMP. ZON	ZONE 17	ZONE 14
		% CONT.:	67.	27.	3.	2.	97.	2.	0.	0.
6	ZONE 27	ZONE ID:	ZONE 17	ZONE 27	ZONE 25	ZONE 18	ZONE 27	ZONE 25	ZONE 17	ZONE 18
		% CONT.:	34.	27.	25.	11.	62.	16.	13.	7.
7	ZONE 2 =	ZONE ID:	ZONE 6	ZONE 5	ZONE 2 =	ZONE 30	ZONE 6	ZONE 2 =	ZONE 31	ZONE 30
		% CONT.:	87.	4.	4.	3.	94.	5.	1.	0.
10	ZONE 19	ZONE ID:	ZONE 32	ZONE 19 =	ZONE 12A	ZONE 29	ZONE 19 =	ZONE 32	ZONE 12A	ZONE 29
		% CONT.:	45.	40.	10.	4.	59.	40.	1.	0.
11	CZ = ZON	ZONE ID:	CZ = ZONE	ZONE 17	ZONE 11	ZONE 15	CZ = ZONE	ZONE 17	ZONE 11	ZONE 15
		% CONT.:	43.	16.	13.	13.	89.	5.	4.	2.
12	ZONE 4 =	ZONE ID:	ZONE 6	ZONE 7	ZONE 3	ZONE 15	ZONE 6	ZONE 15	ZONE 3	ZONE 7
		% CONT.:	33.	19.	18.	15.	43.	33.	23.	1.
13	CZ 15	ZONE ID:	CZ 15	ZONE 18	ZONE 5	ZONE 1	CZ 15	ZONE 5	ZONE 18	ZONE 1
		% CONT.:	35.	32.	28.	4.	78.	15.	7.	0.

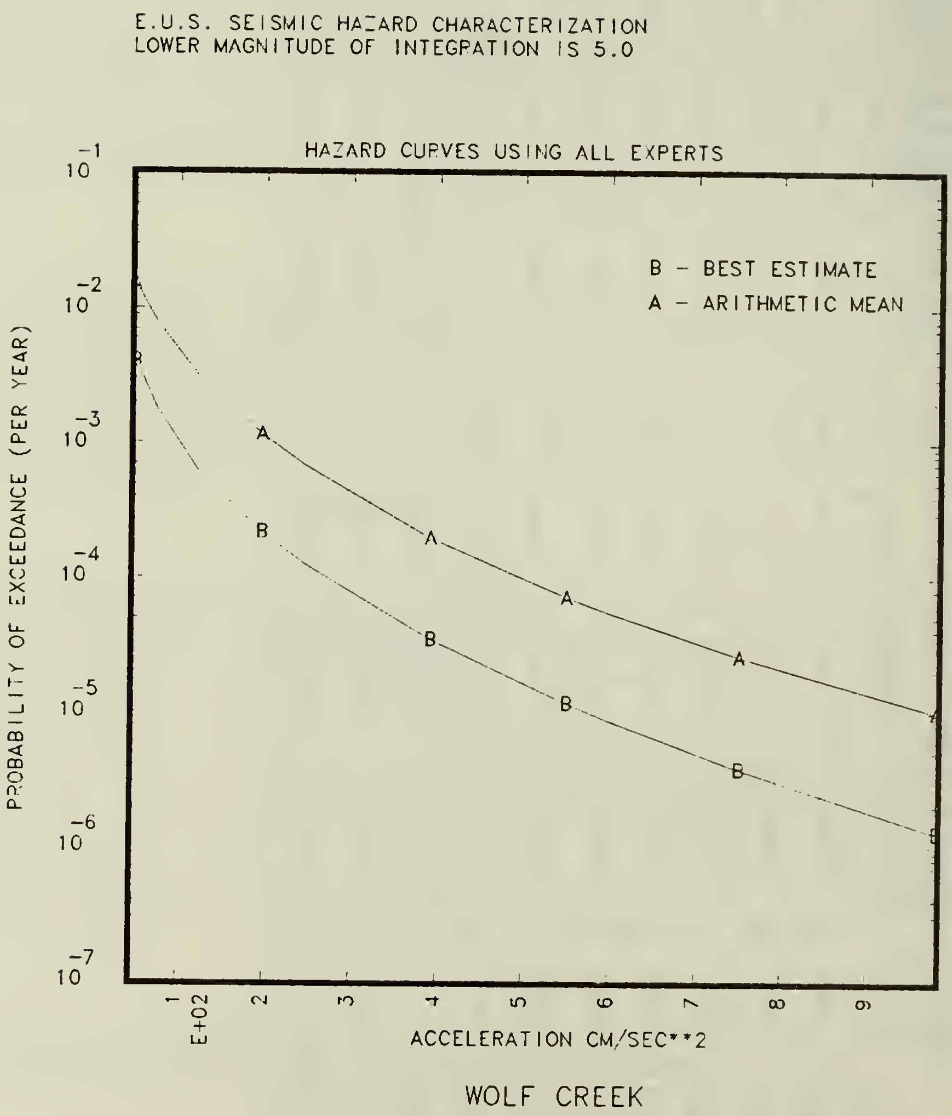


Figure 2.17.1 Comparison of the BEHC and AMHC aggregated over all S and G-Experts for the Wolf Creek site.

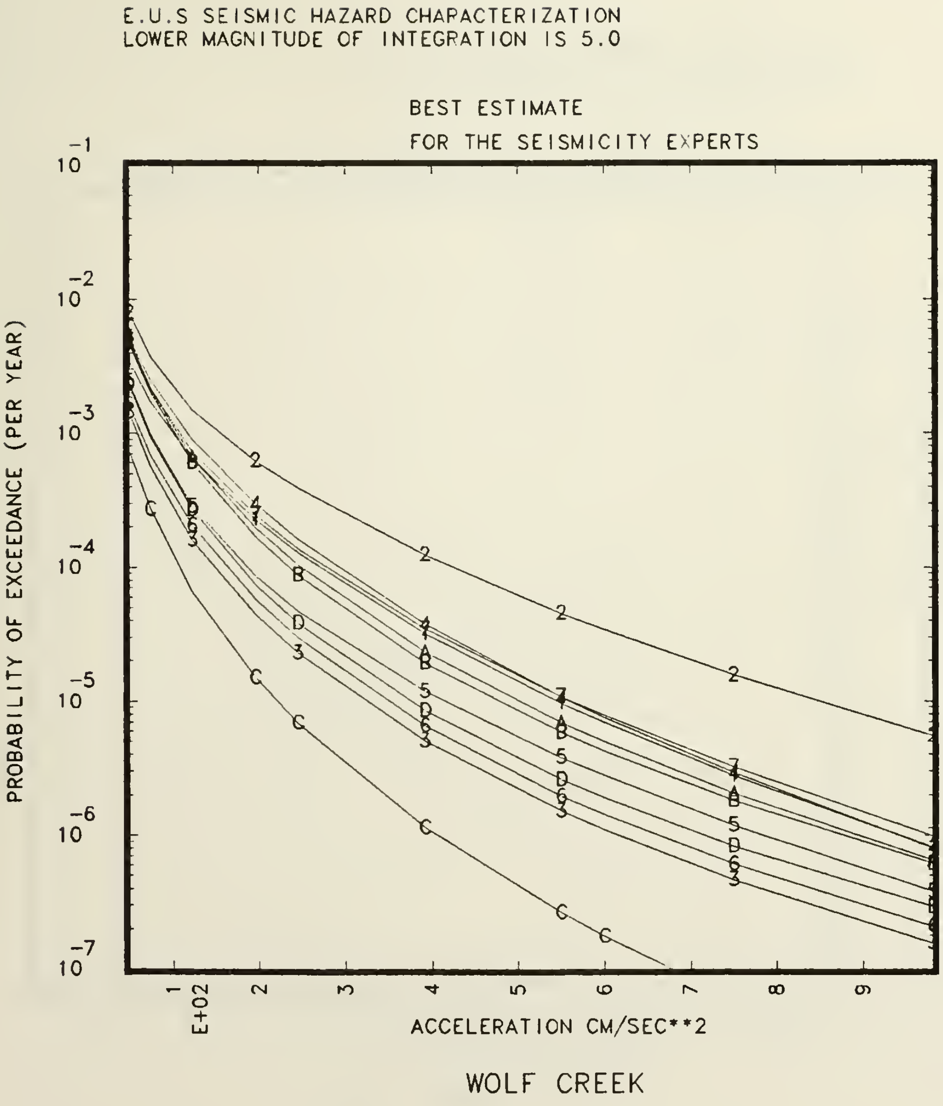


Figure 2.17.2 BEHCs per S-Expert combined over all G-Experts for the Wolf Creek site. Plot symbols given in Table 2.0.

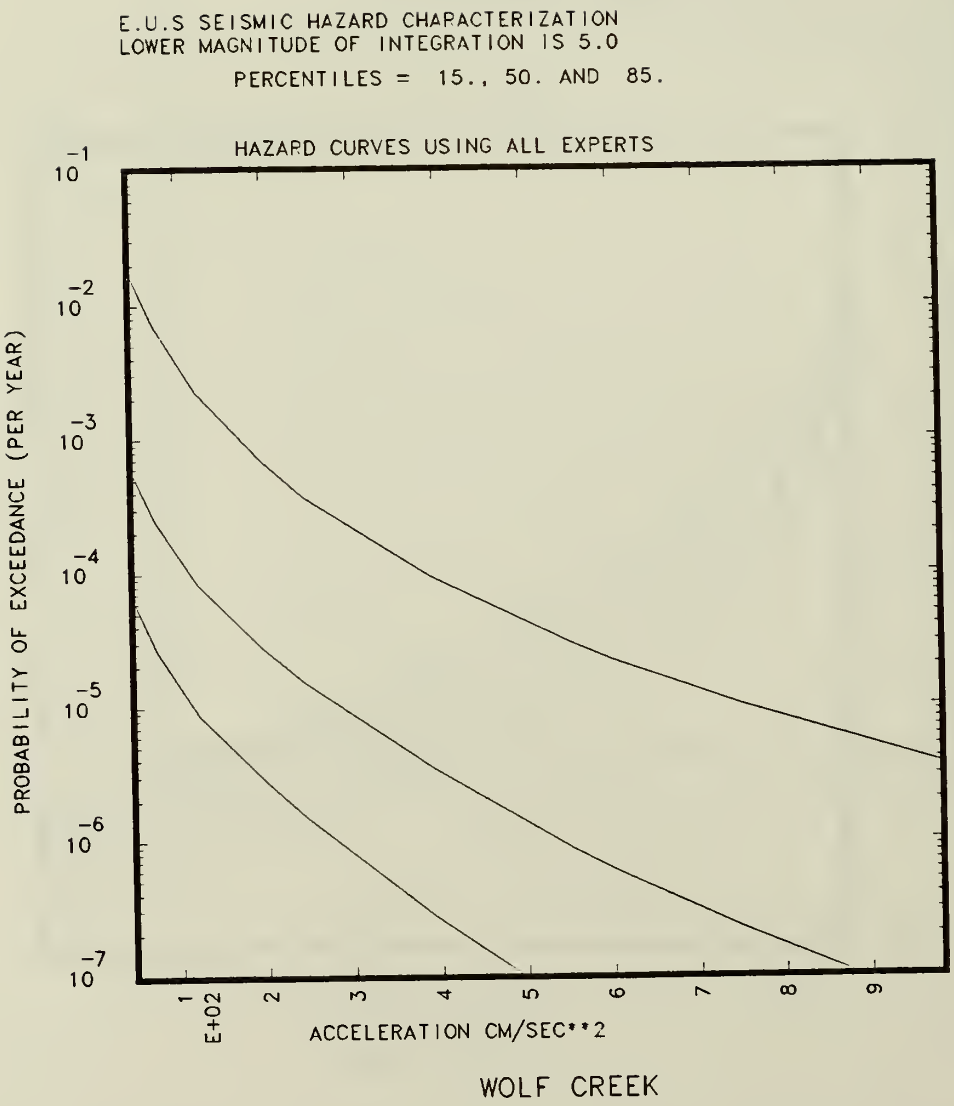


Figure 2.17.3 CPHCs for the 15th, 50th and 85th percentiles based on all S and G-Experts' input for the Wolf Creek site.

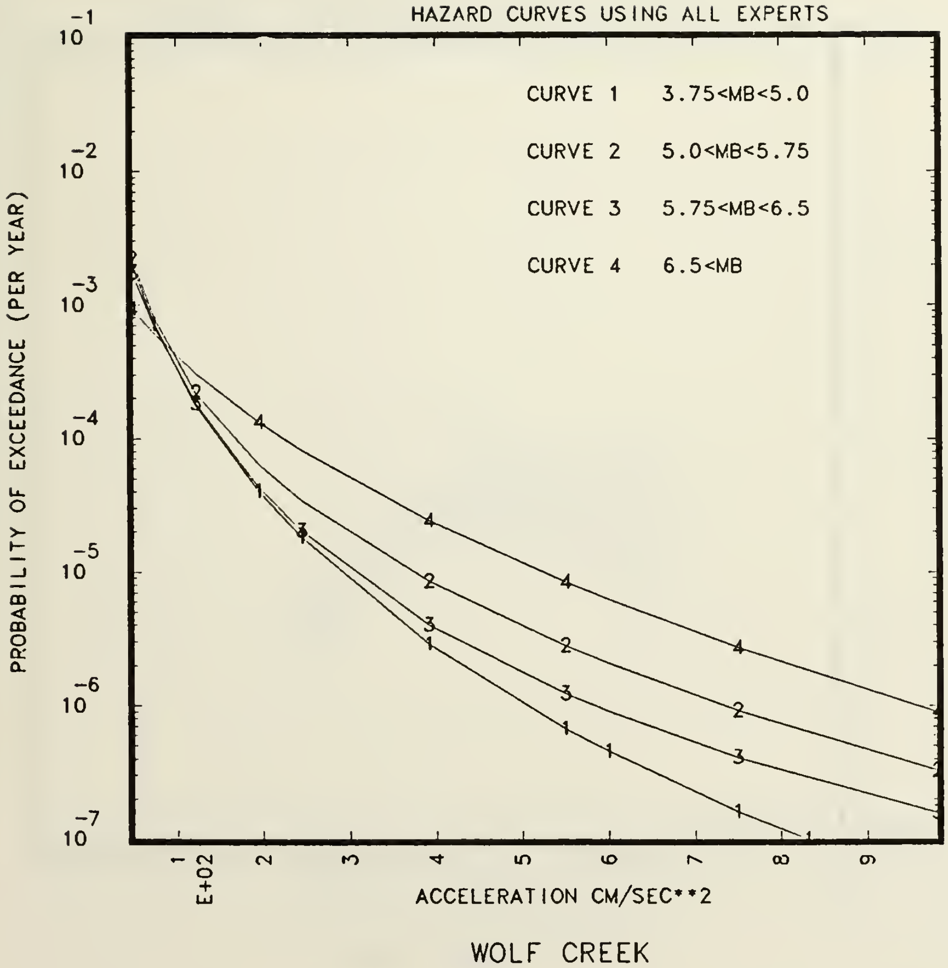
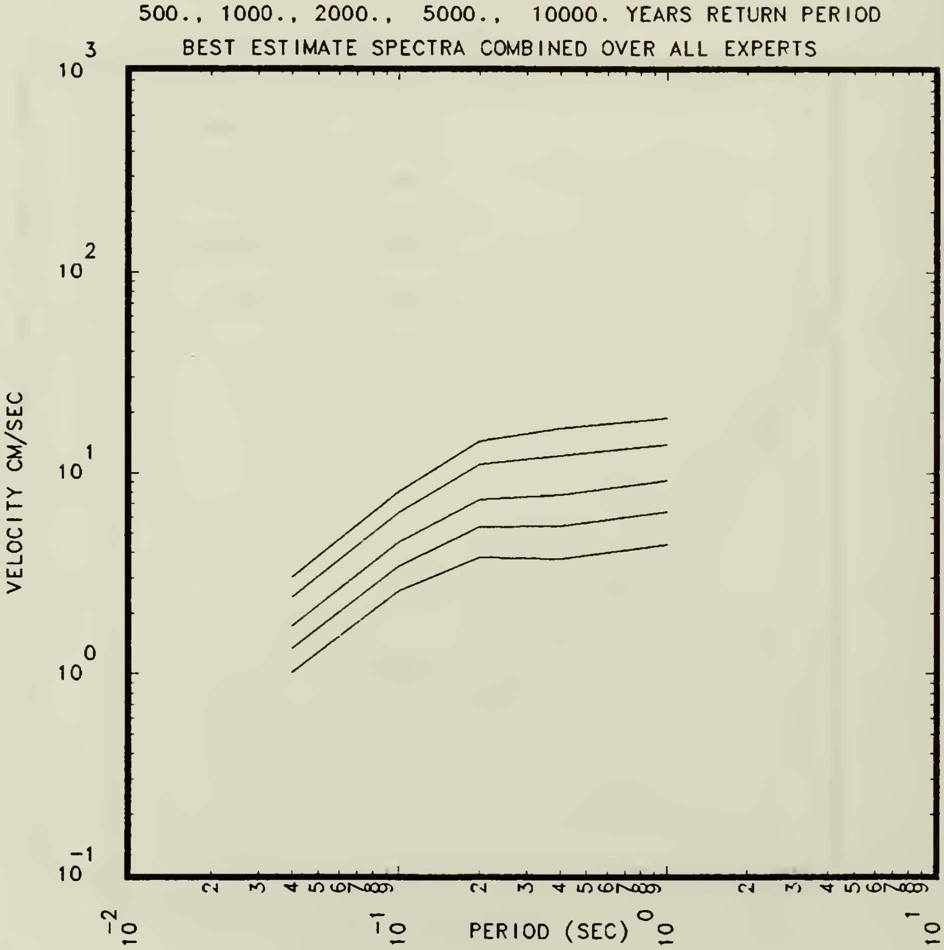


Figure 2.17.4 BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated magnitude range for the Wolf Creek site.

E.U.S SEISMIC HAZARD CHARACTERIZATION
LOWER MAGNITUDE OF INTEGRATION IS 5.0



WOLF CREEK

Figure 2.17.5 BEUHS for return periods of 500, 1000, 2000, 5000 and 10000 years aggregated over all S and G-Experts for the Wolf Creek site.

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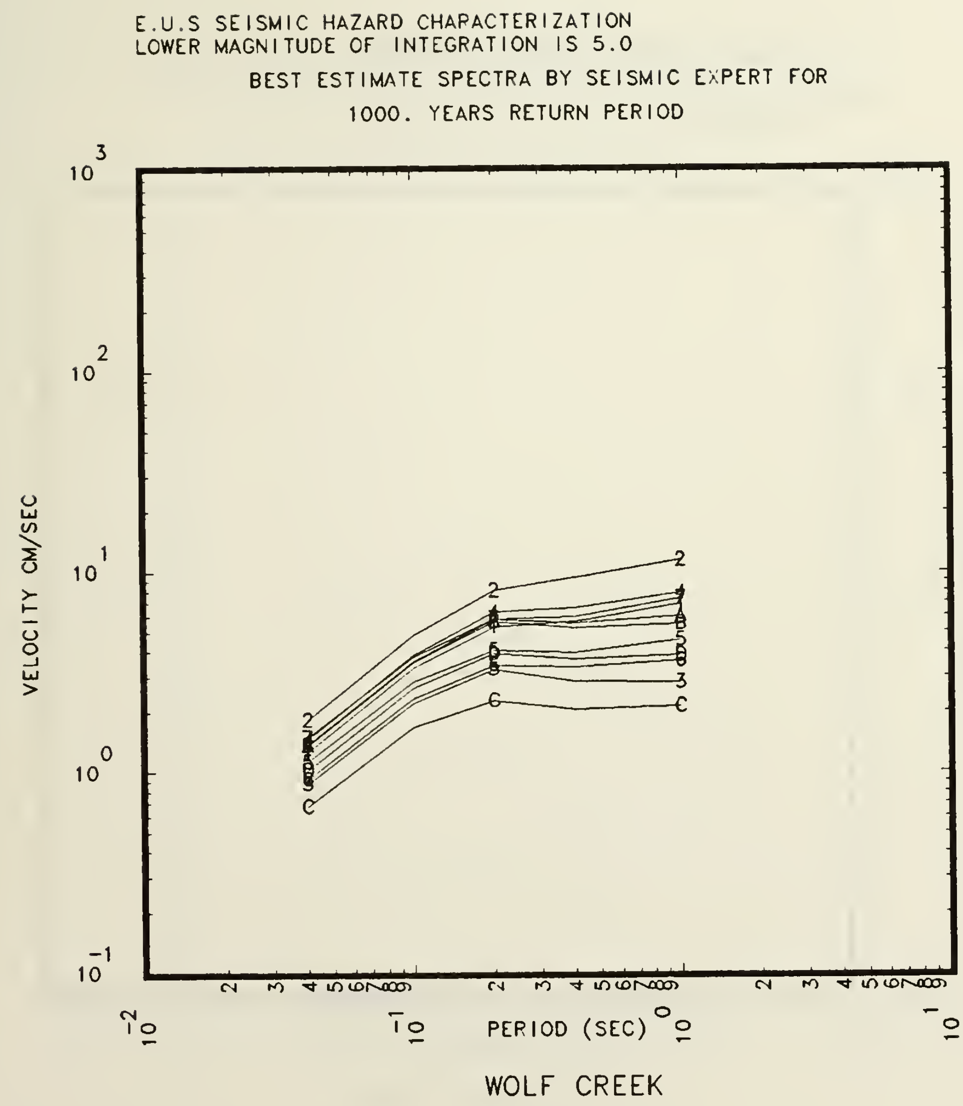

Figure 2.17.6 The 1000 year return period BEUHS per S-Expert aggregated over all G-Experts for the Wolf Creek site. Plot symbols are given in Table 2.0.

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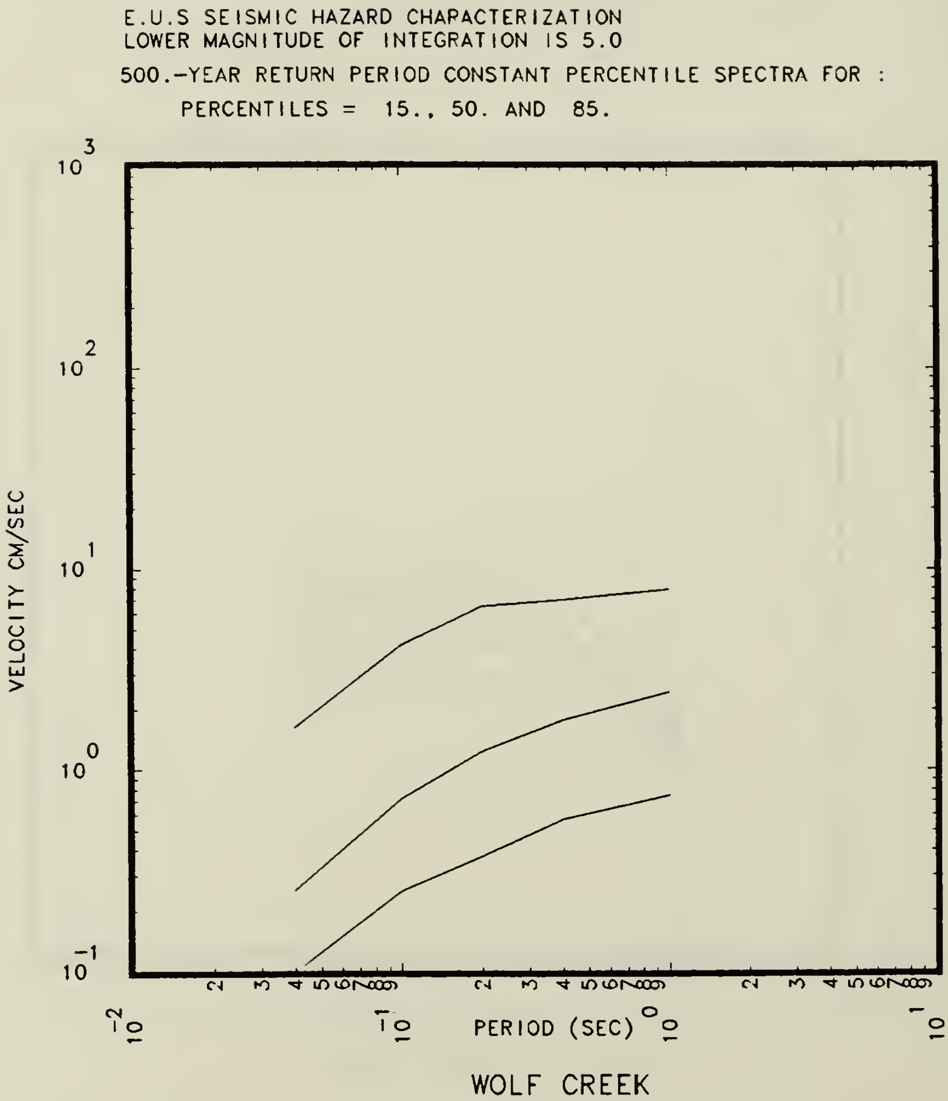

Figure 2.17.7 500 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Wolf Creek site.

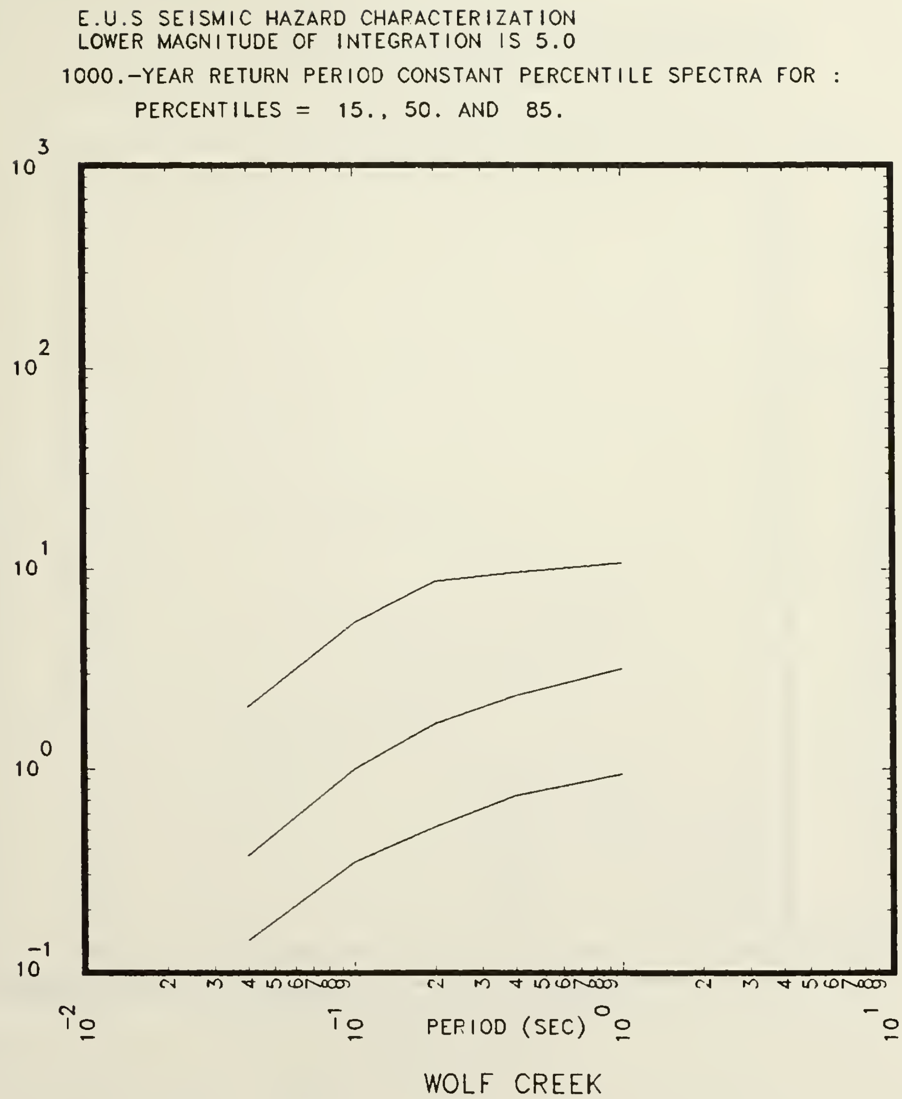

Figure 2.17.8 1000 year return period CPUHS for the 15th, 50th and 85th percentile aggregated over all S and G-Experts for the Wolf Creek site.

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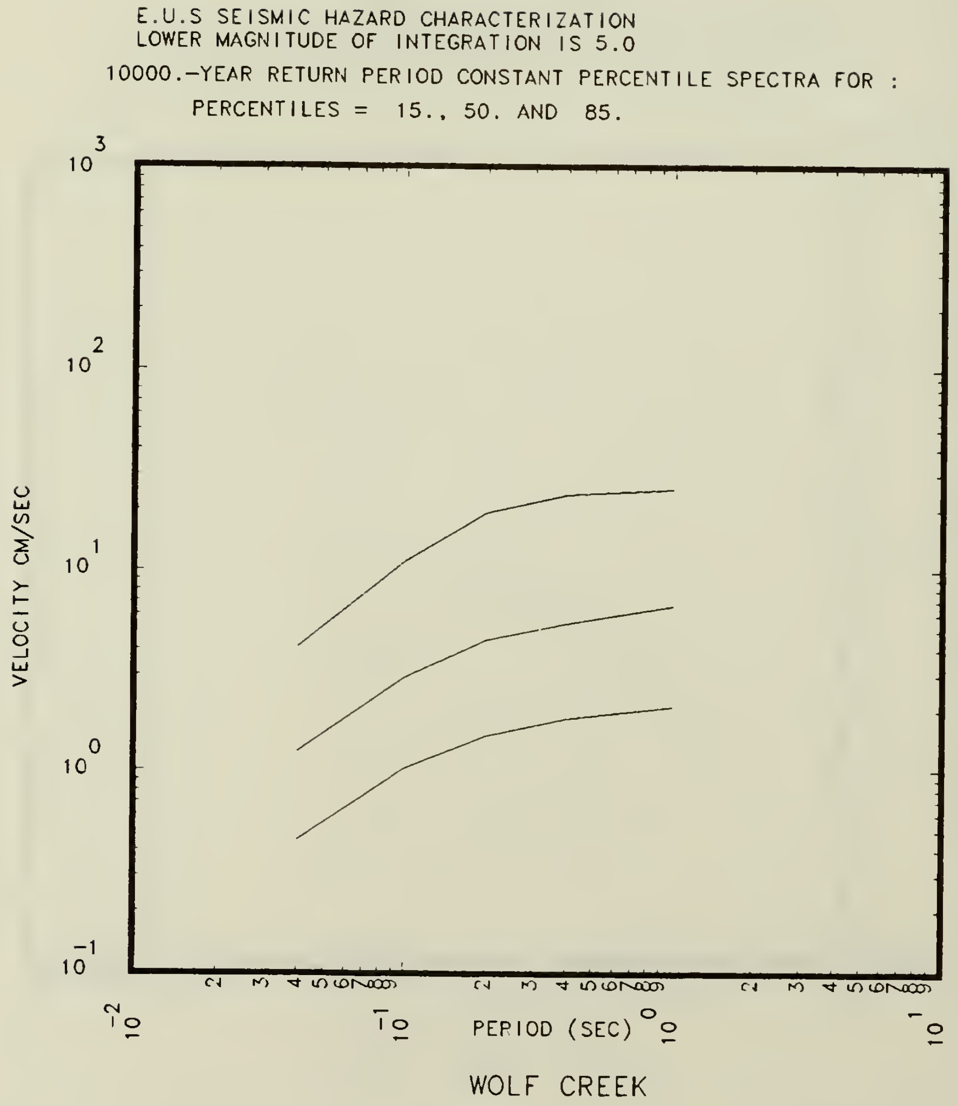

Figure 2.17.9 10000 year return period CPUHS for the 15th, 50th and 85th percentiles aggregated over all S and G-Experts for the Wolf Creek site.

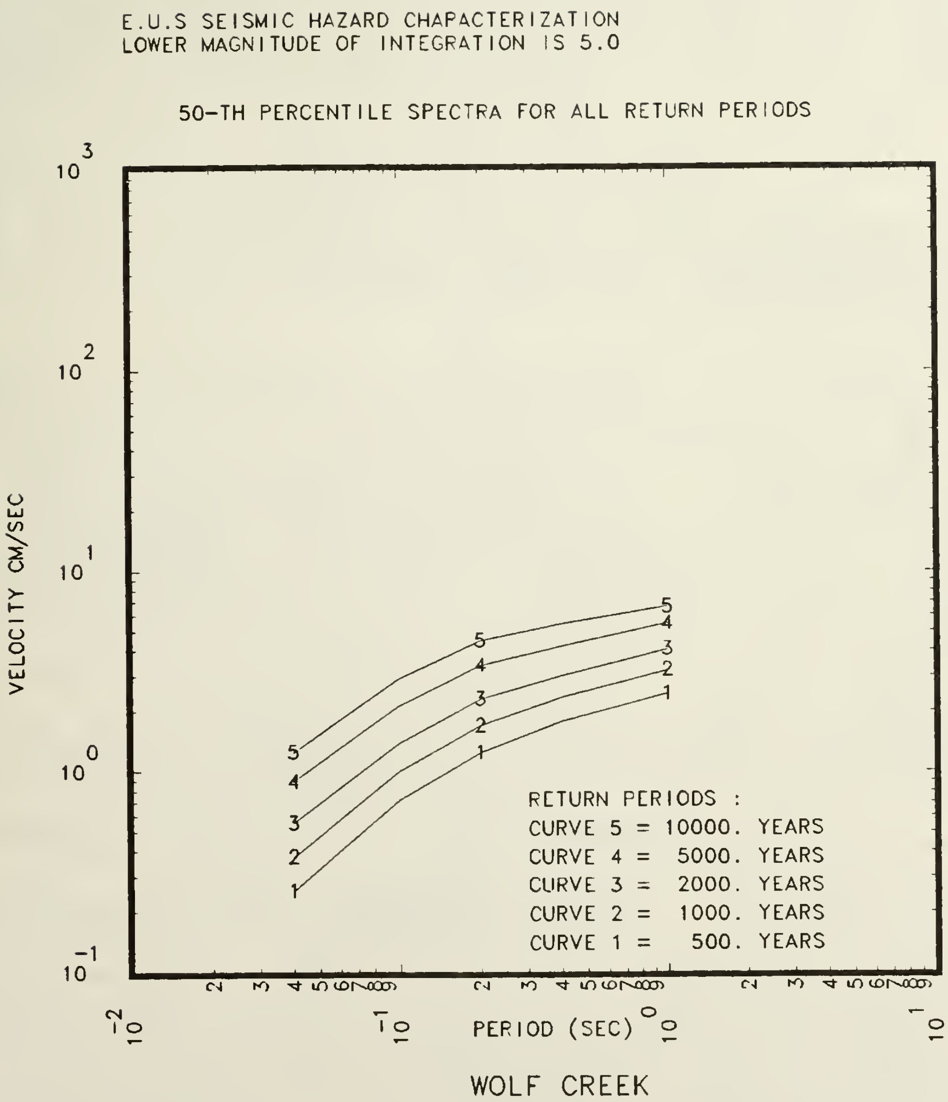

Figure 2.17.10 Comparison of the 50th percentile CPUHS for return periods of 500, 1000, 2000, 5000 and 10000 years for the Wolf Creek site.

3. GENERAL DISCUSSION, REGIONAL OBSERVATIONS, AND COMPARISONS BETWEEN SITES

3.1 Uncertainty

Section 2 shows that there are significant differences in the estimated seismic hazard for any site between various experts. In addition, each expert has typically expressed significant uncertainty about his own input which leads to significant uncertainty in the aggregated estimate of the seismic hazard at any site. As explained in Volume 1, we have used a Monte Carlo analysis to develop the distribution function for the seismic hazard. In addition to the uncertainty due to the variety of experts we investigated the variability in the results due to the limitations on the number of simulations in our Monte Carlo uncertainty analysis. For example, to illustrate this uncertainty in Vol. II, Fig. 3.1.1a, we compared the CPHCs for PGA between Hope Creek and Salem sites. Hope Creek and Salem are located side by side. Thus the comparison represents two different sets of simulations for the same site. For ease of reference, this figure has been repeated in this volume as Fig. 3.1.1. We see from Fig. 3.1.1 that the median curve is well established and that there are only slight differences between the bounds (as measured by the 15th and 85th percentile curves). There are also only slight differences between the AMHCs for the two different Monte Carlo runs.

A detailed examination of the 2750 hazard curves generated in a Monte Carlo run for a typical site suggests that the distribution of the hazard for a given value of the ground motion parameter (e.g., PGA) is approximately log-normal. However there are some sites where there is a marked departure from a lognormal distribution. This phenomenon has been studied in detail in Section 3 of Volume II. It was found that it was likely to happen for rock sites, such as the Fitzpatrick rock site in Vol. II and the Arkansas site in this volume. We repeat here some of Section 3.1 of Volume II for the Fitzpatrick site, but it also applies to other rock sites where there is a larger spread between the median and the 85th percentile CPHCs than between the 15th percentile CPHC and the median such as observed in Fig. 2.1.3 for the Arkansas site. In Fig. 3.1.2 we compare the CPHCs for PGA for two different Monte Carlo runs. We see from Fig. 3.1.2 that there is a larger difference between the median curves for the two Monte Carlo runs than shown in Fig. 3.1.1. In fact, Fig. 3.1.2 suggests that the 15th and 85th percentile curves are better defined than the median. If reference is made to Figs. 2.1.11 and 2.1.12 it is easy to see what is occurring. That is, as discussed in Section 2.1, G-Expert 5's GM model leads to hazard curves significantly higher than for most other GM modes. Thus, the distribution of hazard curves departs from a lognormal distribution and becomes bimodal so that the 15th and 85th percentile curves are relatively well defined but the 50th percentile curve is less well defined. However, even in this worst case, the differences between two Monte Carlo runs are not really large. It varies from practically no difference at low PGA values, say below 0.2g, to differences in the range of 10 percent (in the probability of exceedance) at values above 0.6g. Nevertheless, these differences between two Monte Carlo runs must be kept in mind when making comparisons between nearby sites.

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3.2 Sensitivity to Region Choice

In Volume I we indicated that we divided the EUS into four regions (northeast, southeast, northcentral, and southcentral) in order to give our G-Experts a chance to introduce regional corrections for attenuation and to give our S-Experts a chance to account for varying expertise for different regions. The boundaries between these regions are very approximate, thus several sites could be also considered to be in either region 1, 2 or 3. The major impact of region placement is due to G-Expert 2's input. As can be seen from Tables 3.5 and 3.6 of Volume 1, only G-Expert 2 introduced a regional variation in his GM models. In region 1 he selected a different BE model than for regions 2,3 and 4. Thus the BEHC and BEUHS change depending upon whether the site is considered to be region 1 or the other regions. This however has no influence on the estimate of hazard for the sites considered in this report (batch 4) since none of them belong to region 1. In addition, as shown in Vol. II, the sensitivity to region placement is low.

3.3 Factors Influencing Zonal Contribution to the Hazard

A number of factors influence how significantly a given seismic source zone contributes to the hazard at any given site for any given S-Expert. Several factors are obvious and a few may not be so obvious. The main factors that influence zonal contribution to the hazard can be separated into three groups:

1. Attributes of the seismic zone in question:

    - o Distance from the zone to the site.
    - o The rate of activity in the zone.
    - o The b-value used for the zone.
    - o The upper magnitude cut off for the zone.
    - o The probability of existence of the zone.
    - o The size of the zone.

2. Attributes of the ground motion model:

    - o The rate at which the peak ground motion attenuates with distance.
    - o The site's soil category.

3. Attributes of the hazard analysis methodology:

    - o Uncertainty analysis performed.
    - o Lower bound of integration for magnitude.

Let us start our discussion on the significance of the above factors in the inverse order, i.e. start with set listed under (3) above. We made the point in Section 2 that the Tables 2.SN.1 were based only on BE input and thus did not in all cases capture the true contribution of a given zone to the hazard for a specific site. The contribution of a given zone listed in Tables 2.SN.1 might be too high if a zone's probability of existence is relatively low and it is not listed if the probability of existence is less than 0.5 because in this latter case the zone could not belong to the BE map.

In our analysis the modeling uncertainty in the site correction is accounted for by allowing for several different types of corrections to be performed (see Section 3.7 Vol. I). The type of correction performed also can impact on how the ground motion model (or models) affect the seismic hazard and how correction for the site's soil category is made. This will be discussed later. Other elements of the uncertainty analysis such as the variation in zone boundary shape, variation in rate of activity etc. are less important and generally do not play a major role in determining the zonal contribution to the hazard.

The lower bound for magnitude used in the analysis is of some significance at the low g-value end. This is illustrated in Figs. 3.3.1a and 3.3.1b. In Fig. 3.3.1a we show the contribution to the BEHC for PGA from all the earthquakes in four distance rings about a site in the EUS when the lower bound of integration for magnitude is 5.0. In Fig. 3.3.1b we show the same thing except the lower bound of integration has been reduced to 3.75. We see by comparing Fig. 3.3.1a to 3.3.1b that, when the lower bound of integration is lowered to 3.75, the earthquakes in the region within 15 km of the site contribute significantly more to the hazard at lower PGA levels and there is also a marked increase in the contribution from earthquakes within 15 to 50 km from the site. At high PGA levels there is little effect of changing the lower bound of integration. Of course, if the lower bound was yet even higher than 5, the effect would be more significant even to much higher PGA levels.

Let us now address group (2) - attributes of the GM model. First, let us note that if there were no modeling uncertainty, (i.e., if we knew the correct form for the GM model) then the attributes of the GM model would not influence the zonal contribution. If no uncertainty analysis is being performed (e.g. Algermissen et. Al. (1982)) then it is the same as saying we know the correct form for the GM model. In our analysis we have included uncertainty about GM modeling in three ways:

(1) We used multiple GM models.
(2) We introduced multiple ways to correct for the effect that the site's category has on the estimated ground motion.
(3) We varied the random uncertainty associated with each GM model.

All three of the above are important.

In section 2.1 we have already made the point that one of the BE GM models has a significantly lower attenuation rate than the other BE GM models. This can make a significant difference. In Fig. 3.3.2 we plot for the same site as in Fig. 3.3.1a the contribution to the BEHC from the earthquakes located in four distance ranges except only G-Experts 1-4's BE GM models are used. That is, we have eliminated the GM model with low attenuation. It is evident from comparing Figs. 3.3.1a and 3.3.2 that the uncertainty about the correct GM model is very significant and can have an important impact on determining which zones contribute to the hazard at a site.

Our uncertainty about how to correct the GM for the soil conditions at a site impacts the estimate of the ground motion differently for various ground

motion models. This is illustrated in Figs. 3.3.3a and 3.3.3b. In Fig. 3.3.3a we show the contribution to the BEHC for PGA for four distance ranges for a rock site located in the EUS. In Fig. 3.3.3.b we show the contribution to the BEHC for PGA for the same four distance ranges for a soil site. The soil site was placed in the Till-2 soil category. The two sites are located relatively close to each other thus we would expect little difference in the seismic hazard between these two sites. We see however from comparing Figs. 3.3.3a and 3.3.3b that there is a considerable difference between the two sites in the distance ranges which contribute most to the BEHCs for PGA.

It should be noted that the differences between the distribution of which distance bands contribute most to the BEHCs for PGA for rock sites as compared to soil sites is typically the difference between Figs. 3.3.3a and 3.3.3b. However, there is some variation between the various rock sites and the various soil sites depending upon their location.

The group (1) - attributes of the zone in question-are relatively easy to understand and are generally the factors which we expect to control a given zone's contribution to the seismic hazard at a site. In Section 2 we gave examples of how the group (1) factors influence this contribution.

From the above discussion we can conclude that care must be taken when using the information given in Table 2.1.1 to 2.17.1. The information is useful, but, as indicated, it can give a distorted picture of which zones are most significant. Unfortunately, in complex cases the only way to get an undistorted understanding is to perform a detailed sensitivity analysis. However, one can gain a relatively good understanding of what is important by carefully examining the data given in Tables 2.SN.1, the zonation maps for each S-Expert, the seismicity data for each S-Expert given in Appendix B and keeping in mind the sensitivities discussed in this section.

3.4 Comparisons of the Seismic Hazard Between Sites

In this project the seismic hazard has been defined as the annual probability of exceedance of a given level of peak ground motion. Thus, strictly speaking, we only need to compare hazard curves between sites to reach a conclusion about the relative hazard at various sites. However, large uncertainties exist in the estimates of the peak ground motion and in the conversion of a given level of peak ground motion into a risk number. This suggests that we need to also introduce some subjective judgement into the process of assessment of the relative hazard between sites. In this section we compare the computed seismic hazard and examine some important elements that should be factored into assessment of the relative hazard between the sites included in batch 4.

When comparing the hazard between two sites, one of the most important factors to be considered is the potential differences in soil categories between the two sites. For example, in Fig. 3.4.1 we compare the median CPHC for two adjacent sites. We would generally expect that there would be little difference between the seismic hazard for these two sites. However, Fig. 3.4.1 shows that there is considerable difference. One is a rock site,

the other is a soil site (Category Till-2). A complete discussion on the local site effects on ground motion is given in Volume VI, and Fig. 3.4.1 shows that it is very significant.

In addition to soil category, one must consider which estimator of the hazard should be used because in some cases different estimators would lead to different conclusions about the relative hazard between two sites. For example, if the AMHC for the River Bend site, Fig. 2.12.1, is compared to the AMHC for the Waterford site, Fig. 2.16.1, one would conclude that the hazard is much higher at the Waterford site than at the River Bend site. However, the other hazard estimators are very similar for the two sites. Added examples are given in the following paragraphs.

Most of the comparisons made in the rest of this section are relative to the median hazard curve because it proved to be the most stable parameter of all the hazard estimators considered. Generally, the spread between the 15th and 85th CPHCs gives an idea of uncertainty at a given site, however, this spread may not fully capture the uncertainty in which case there will generally be a larger spread between the 50th and 85th CPHCs than the 15th and 50th CPHCs.

As one would expect, the hazard, as shown in Fig. 3.4.2, is not uniform over the large portion of the EUS (northcentral, southcentral, and southeast) which contains the sites in batch 4. In Fig. 3.4.2 we compare the median CPHCs for the seven rock sites of batch 4. The median CPHC is the highest at the Arkansas site and the lowest at the Comanche Peak site.

We see from Fig. 3.4.2 that the median CPHC is significantly higher at the Arkansas site as compared to the Callaway site. We see by comparing Fig. 2.1.4 to Fig. 2.2.4 that the larger ($M > 6.5$) magnitude earthquakes contribute the same level of hazard at the two sites. However, the smaller magnitude earthquakes contribute more to hazard at the Arkansas site than at the Callaway site. Thus the zones other than the New Madrid zones near the Arkansas site are more significant than the zones near the Callaway site.

It is interesting to compare the hazard between the Comanche Peak site and the Turkey Point site. The Comanche Peak site is about as far from the New Madrid region as the Turkey Point site is from the Charleston region. We see from Fig. 3.4.3 that the median CPHCs are about the same for these two sites. We see by comparing Fig. 2.15.1 to 2.3.1 that both the BEHC and the AMHC is much higher at Turkey Point site than at the Comanche Peak site. If Fig. 2.15.2 is compared to Fig. 2.3.2 we see that there is a much larger spread between the S-Experts' BEHCs at the Turkey Point site as compared to the Callaway site. Yet, interestingly, the 85th percentile CPHC is higher at low g-values at the Comanche Peak site than at the Turkey Point site and about the same at the two sites at the high g-value end.

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In. Fig. 3.4.4 we compare the median CPUHS for a 10,000 year return period between the Comanche Peak site and Turkey Point site. At the short period end the two spectra are in agreement, consistent with Fig. 3.4.3. However, at the longer period end we see that the spectral level is significantly higher at the Comanche Peak site as compared to the Turkey Point site. There are two reasons for this difference. First, if Fig. 2.15.4 is compared to Fig. 2.3.4 we see that at a return period of 10,000 years, the small magnitude earthquakes are much more important at the Turkey Point site than at the Comanche Peak site. Secondly, if Fig. 2.3.11 is compared to Fig. 3.4.5, we see at the Comanche Peak site the hazard is primarily from zones at the large distances from the site as compared to the way the hazard is generated from the zones around the Turkey Point site. Thus, we would expect that the CPUHS at the Comanche Peak site would have more long period content than at the Turkey Point site.

Similarly, if the hazard between other sites of the same site category and equally distant from either the New Madrid region or the Charleston region, then the median CPHCs for PGA are approximately the same and the spectral shapes and levels are consistent with the differences observed in Fig. 3.4.4. In Vol. VI we make other comparisons between sites located relatively near either the New Madrid region or the Charleston region.

In Fig. 3.4.6 we compare the median CPHCs between all of the sites listed in Table 1.1. The variation between sites includes the variation between site categories and zonation. We see from Fig. 3.4.6 that the Cooper site has the highest median CPHC. It is interesting to note that the median CPHC for the Cooper site is higher than for either the Callaway or Arkansas sites which are much closer to the New Madrid region. The Cooper site's soil category is sand-like 1 while both the Arkansas and Callaway sites' soil category is rock. This difference in site category is one of the main reasons why the hazard is higher at Cooper than at either the Arkansas or Callaway sites.

It is interesting to contrast between the Cooper site and the Arkansas site how the various distance ranges and magnitude ranges contribute to the hazard. In Fig. 2.1.4 the contribution to the hazard for four magnitude ranges is plotted for the Arkansas site and similarly for the Cooper site in Fig. 2.4.4. For the Cooper site we see that smaller earthquakes are most important and that the large earthquakes from the New Madrid region are not very important. By contrast, the opposite is true at the Arkansas site. Not surprisingly, the contribution to the hazard from distance ranges is significantly different between the sites as can be seen by comparing Fig. 2.1.13 to Fig. 3.4.7. For the Cooper site, as expected, most of the hazard is contributed by zones within 50 km of the site, whereas at the Arkansas site, the more distant New Madrid region is important.

It should be kept in mind that much of the above discussion was based on comparisons between median estimators of the seismic hazard at various sites. As we have pointed out earlier other estimators of the hazard might

lead to different conclusions. To illustrate this point refer to Fig. 3.4.8 which shows several estimators of the probability of exceedance of 0.2g for each of the 17 sites of batch 4.

According to Fig. 3.4.8 the four sites with the highest probability of exceedance of 0.2g are sites number 1, 2, 16 and 17 when the estimator is the Arithmetic mean (symbol A in Fig. 3.4.8). They are sites 1, 2, 4 and 17 when the estimator is the 85th percentile (upper symbol *, in Fig. 3.4.8). They are sites again 1, 2, 4 and 17 when the estimator is the best estimate (symbol B in Fig. 3.4.8) and finally they are sites 1, 4, 7 and 9 when the estimator is the median hazard (symbol M in Fig. 3.4.8).

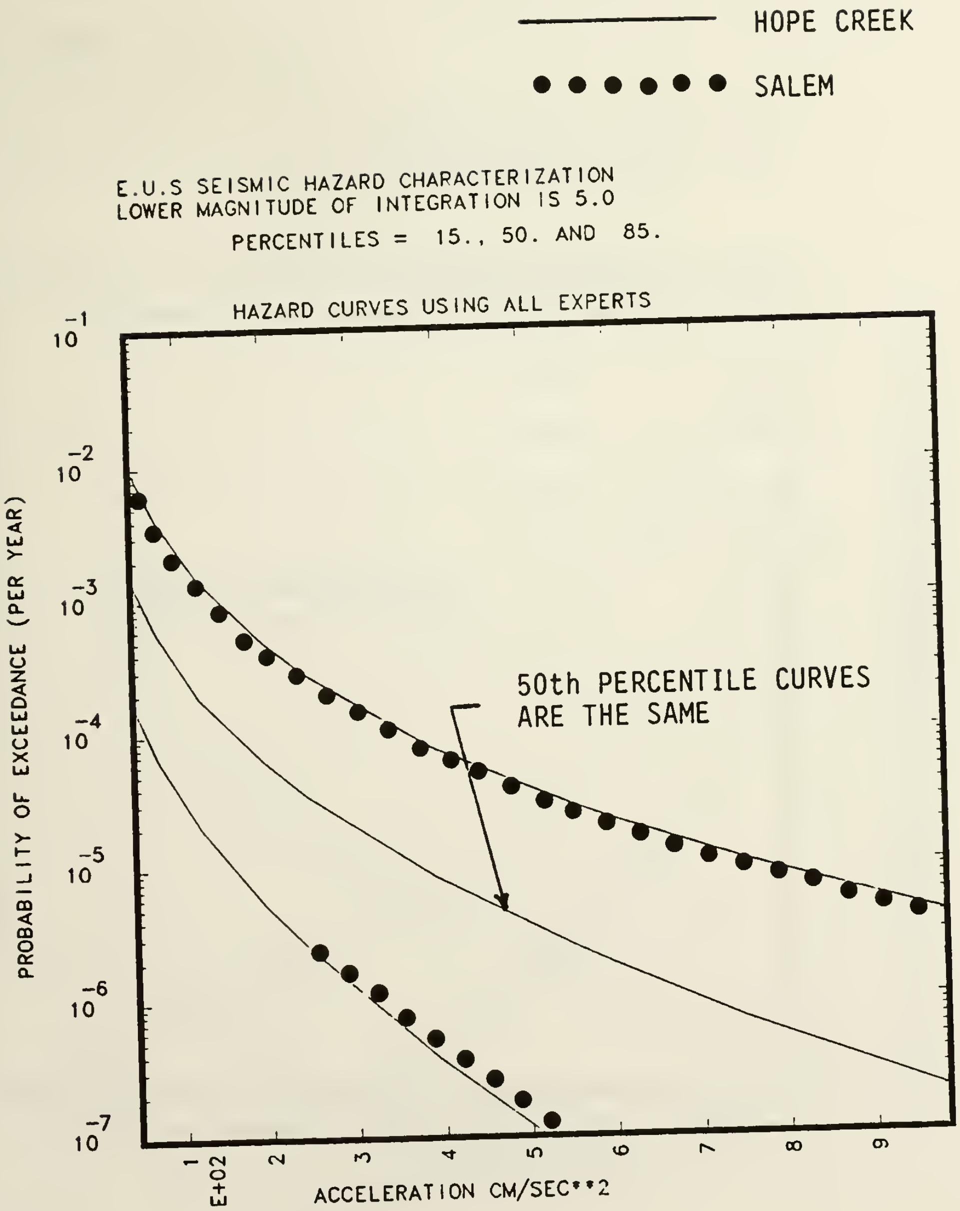

Figure 3.1.1 Comparison of the 15th, 50th and 85th percentile CPHCs for PGA between the Hope Creek and Salem sites. Repeated from Vol. II.

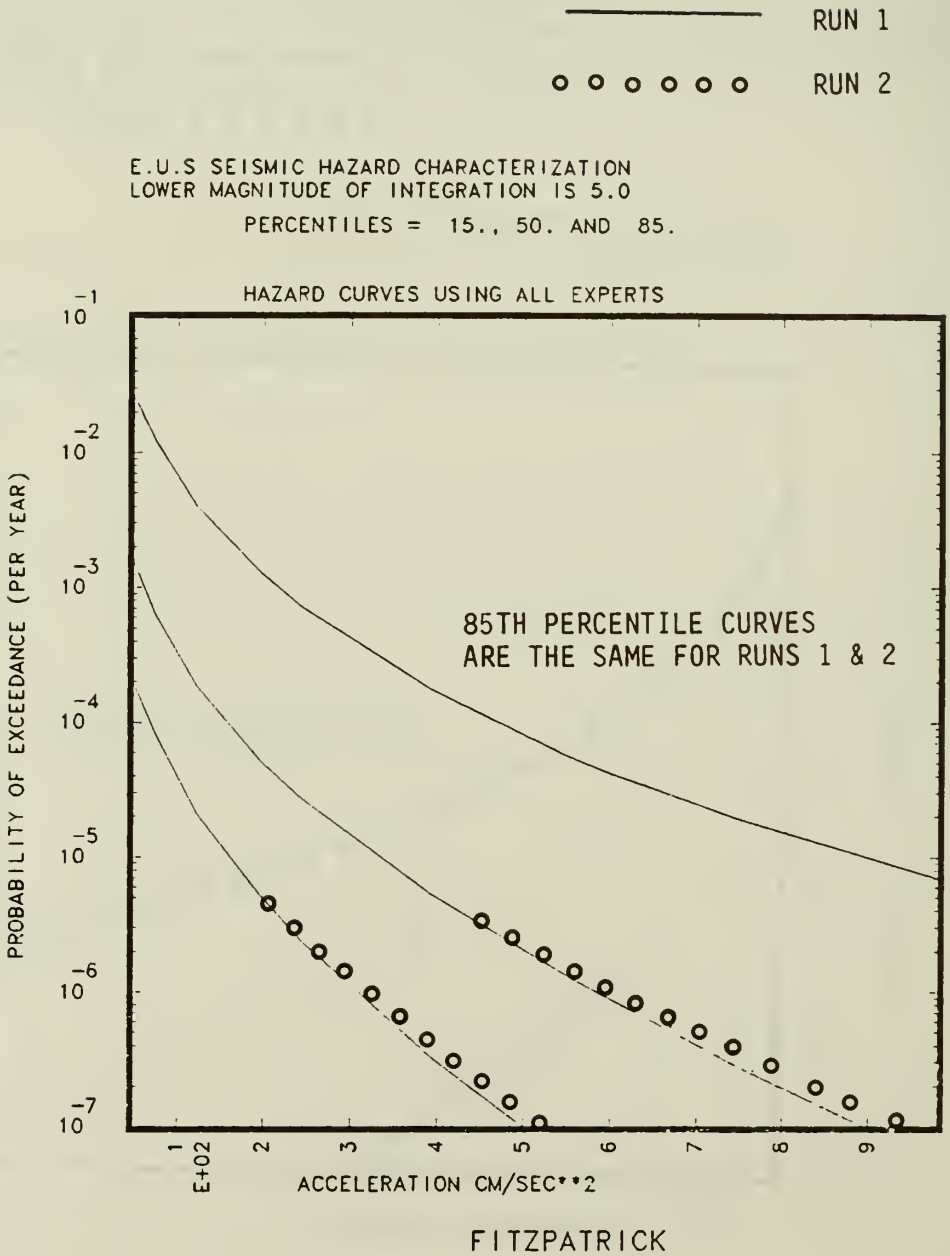

Figure 3.1.2 Comparison of the 15th, 50th and 85th percentile CPHCs for PGA between two different Monte Carlo runs for the Fitzpatrick site. Repeated from Vol. II.

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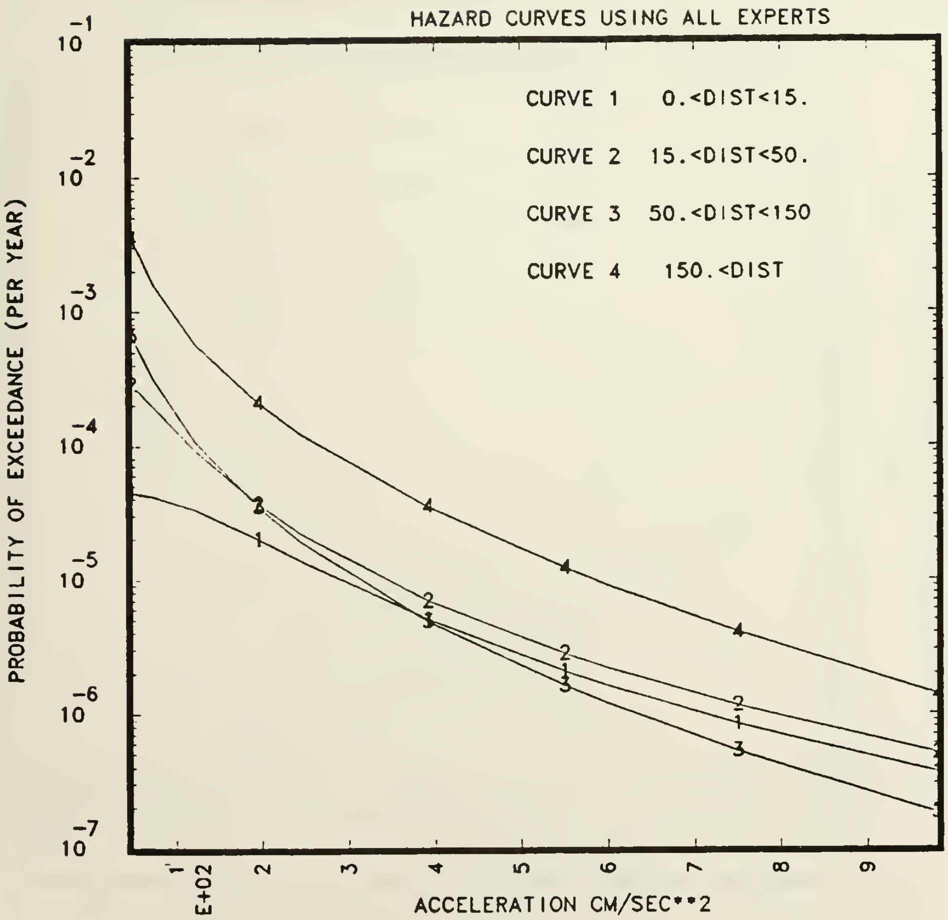

Figure 3.3.1a BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated distance ranges for a site in the EUS when the lower bound of integration for magnitude is 5.0.

CONTRIBUTION TO THE HAZARD FOR PGA (MO=3.75)
FROM THE EARTHQUAKES IN 4 DISTANCE RANGES

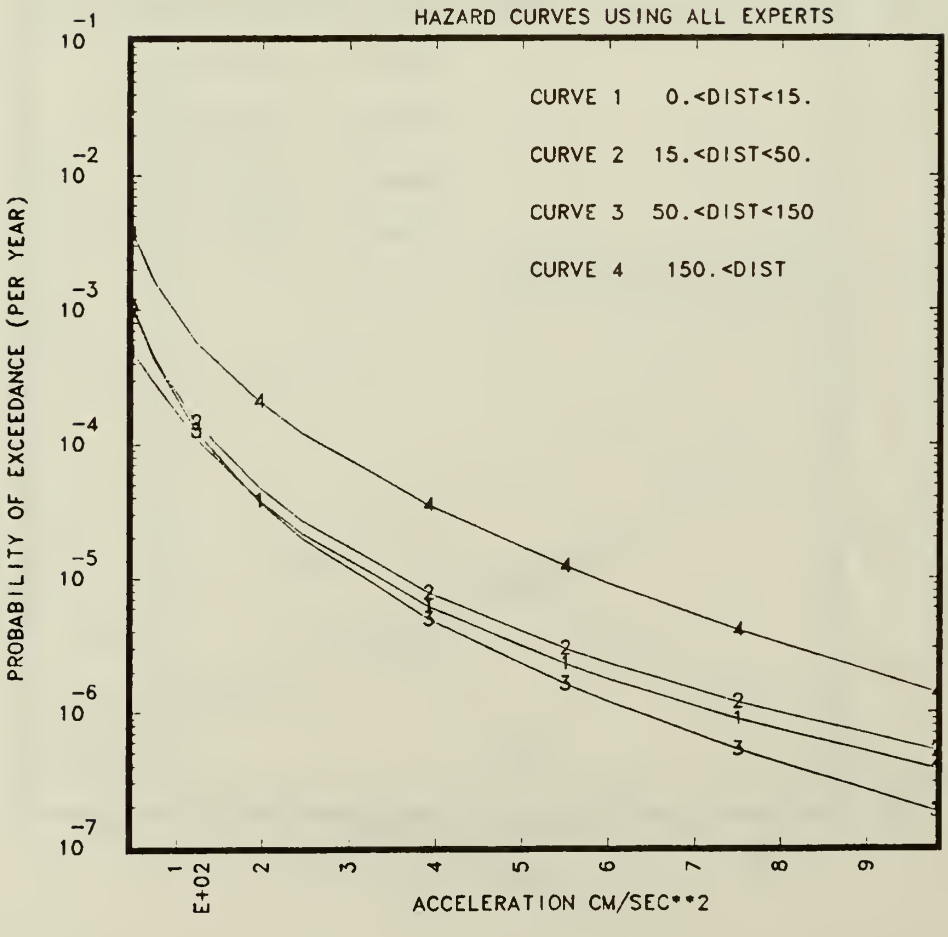

Figure 3.3.1b BEHCs which include only the contribution to the PGA hazard from earthquakes within the indicated distance ranges for the site considered in Fig. 3.3.1a when the lower bound of integration is 3.75.

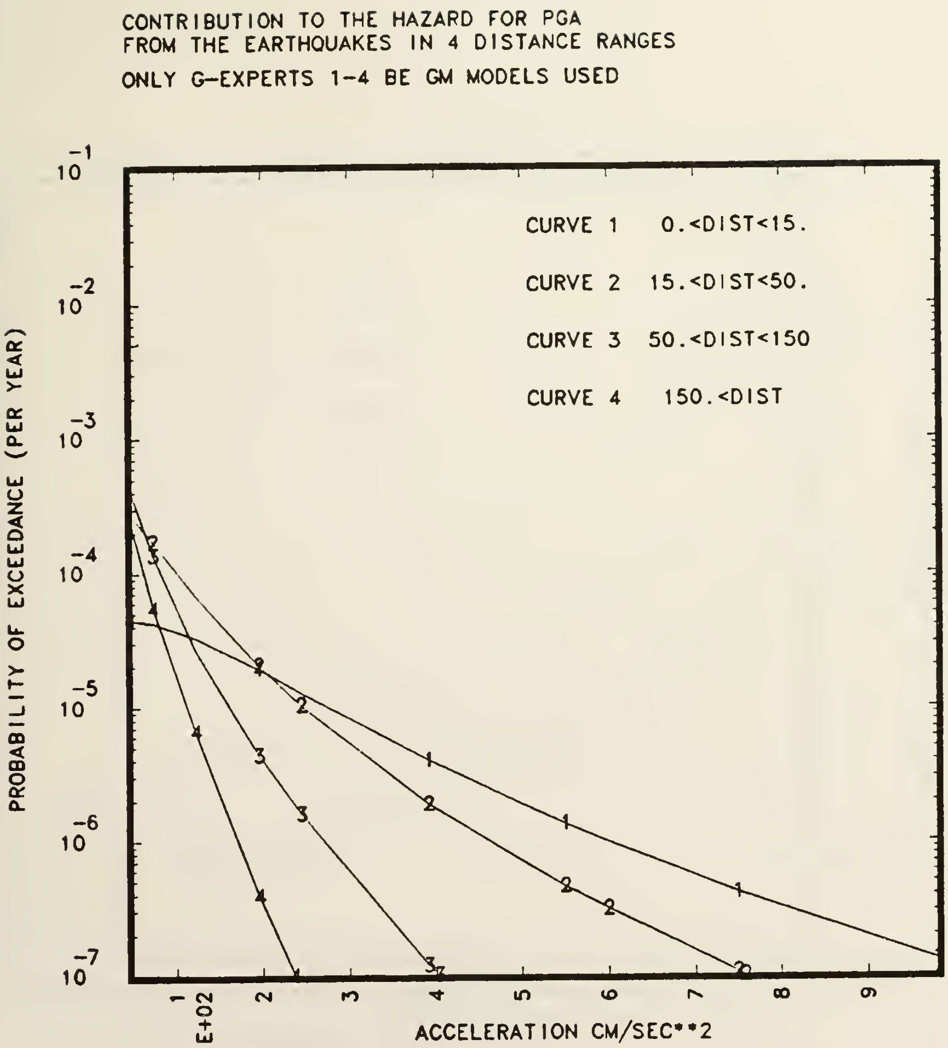

Figure 3.3.2 Same as Fig. 3.3.1a except only G-Experts' 1-4 BE GM models were used.

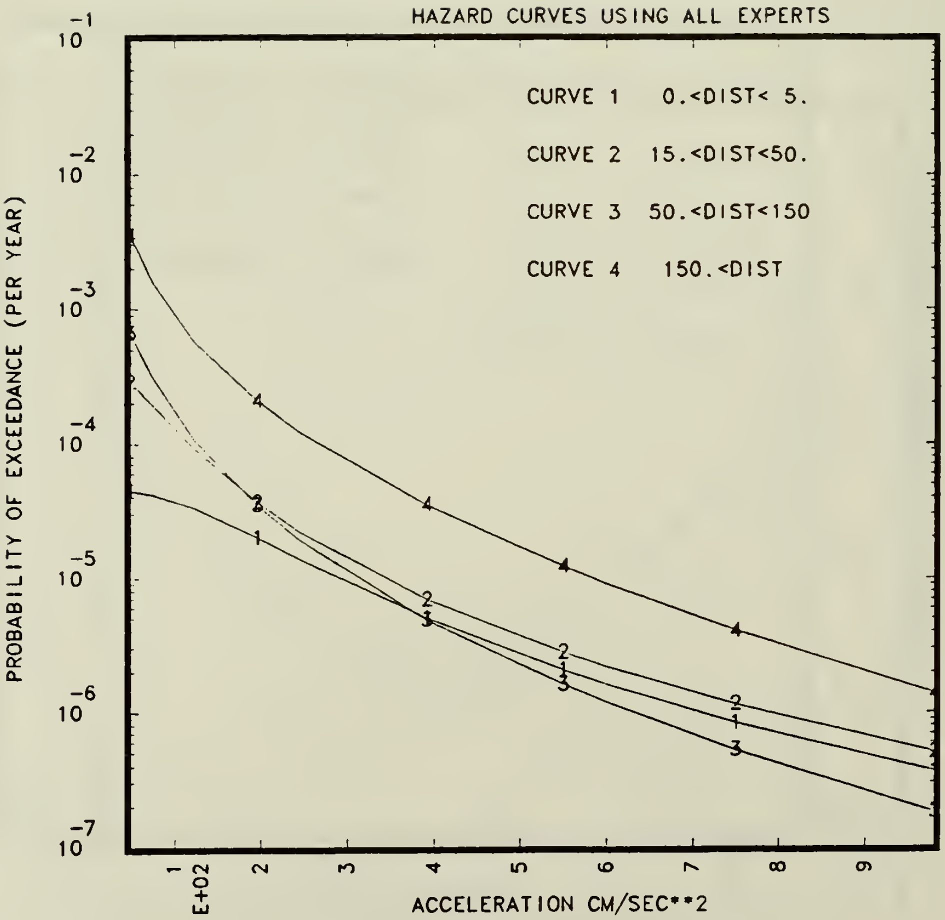

Figure 3.3.3a BEHCs for a rock site located in the EUS which include only the contribution to the hazard for PGA from earthquakes within the indicated distance ranges.

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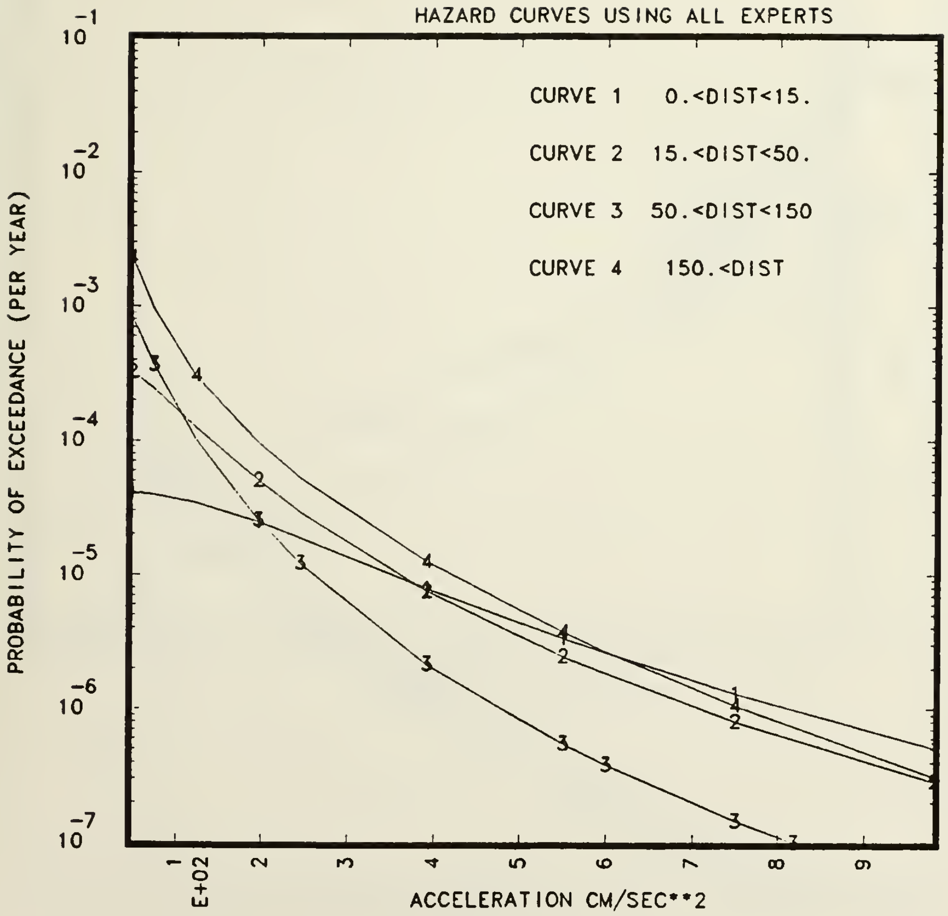

Figure 3.3.3b BEHCs for a soil site located in the EUS close to the rock site of Fig. 3.3.3a which include only the contribution to the PGA hazard from the earthquakes within the indicated distance ranges.

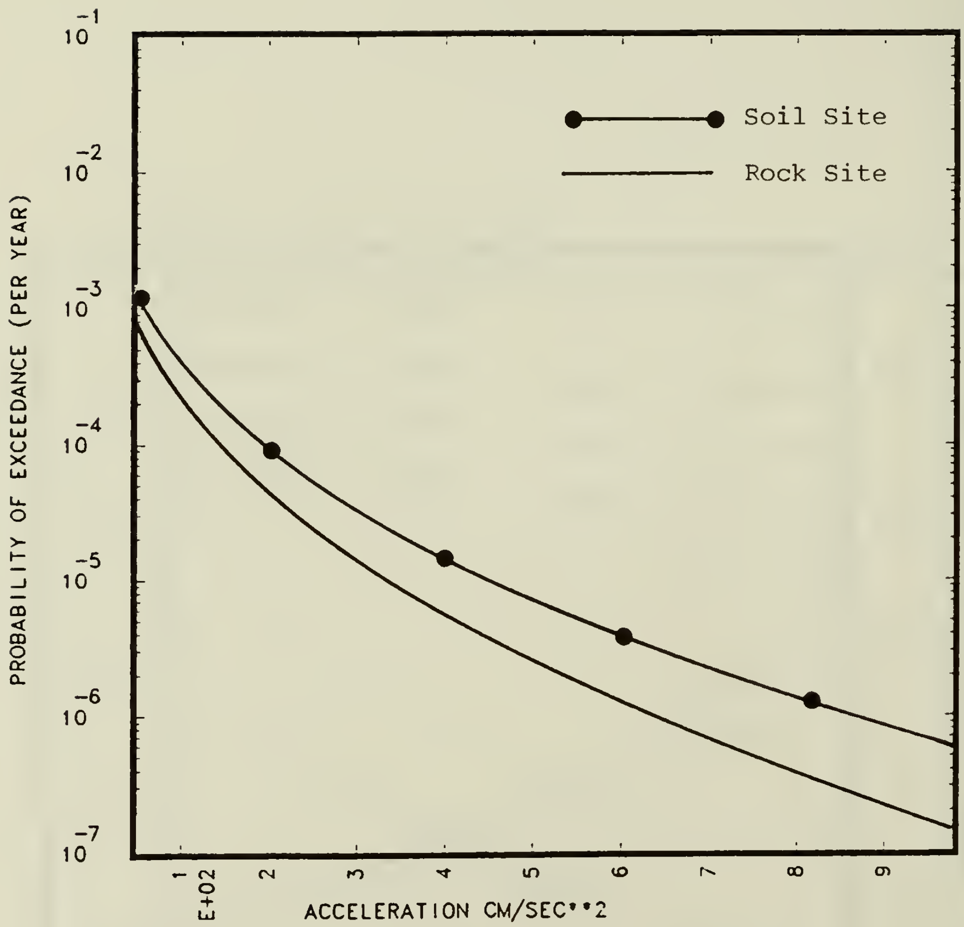

Figure 3.4.1 Comparison of the median CPHCs for PGA between a rock and a contiguous soil site located in the EUS.

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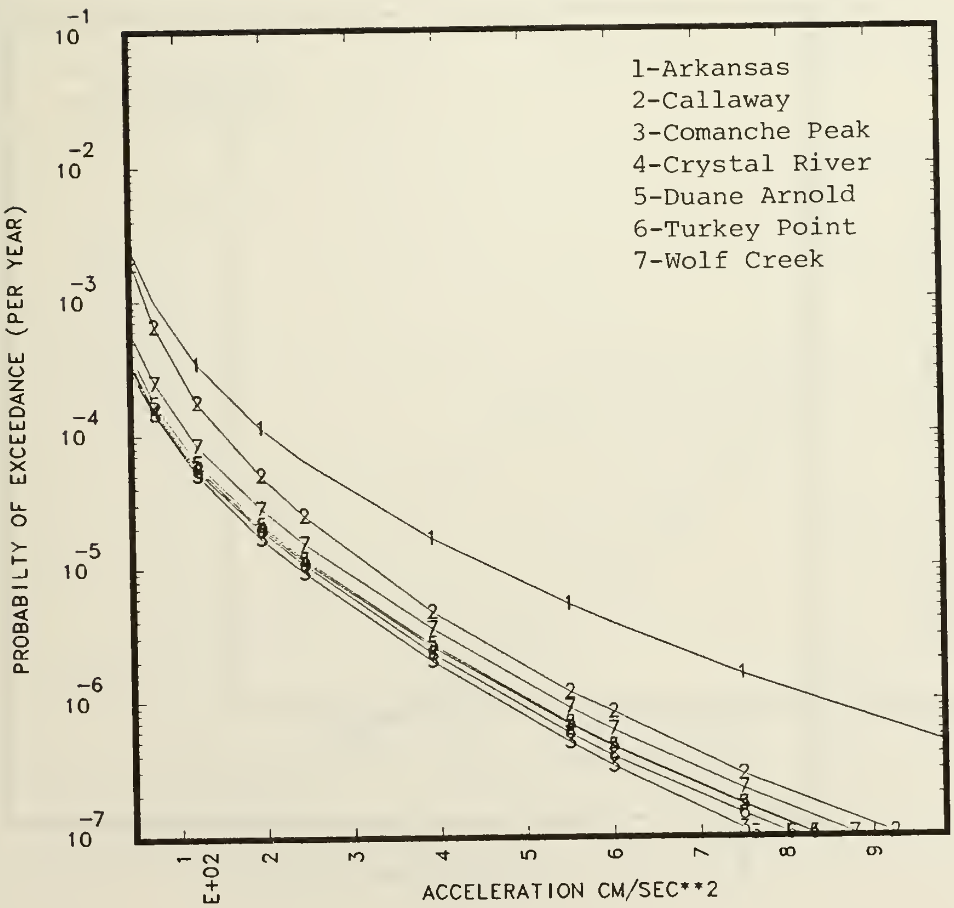

Figure 3.4.2 Comparison of the median CPHCs for PGA for the 7 rock sites of the Batch 4 sites.

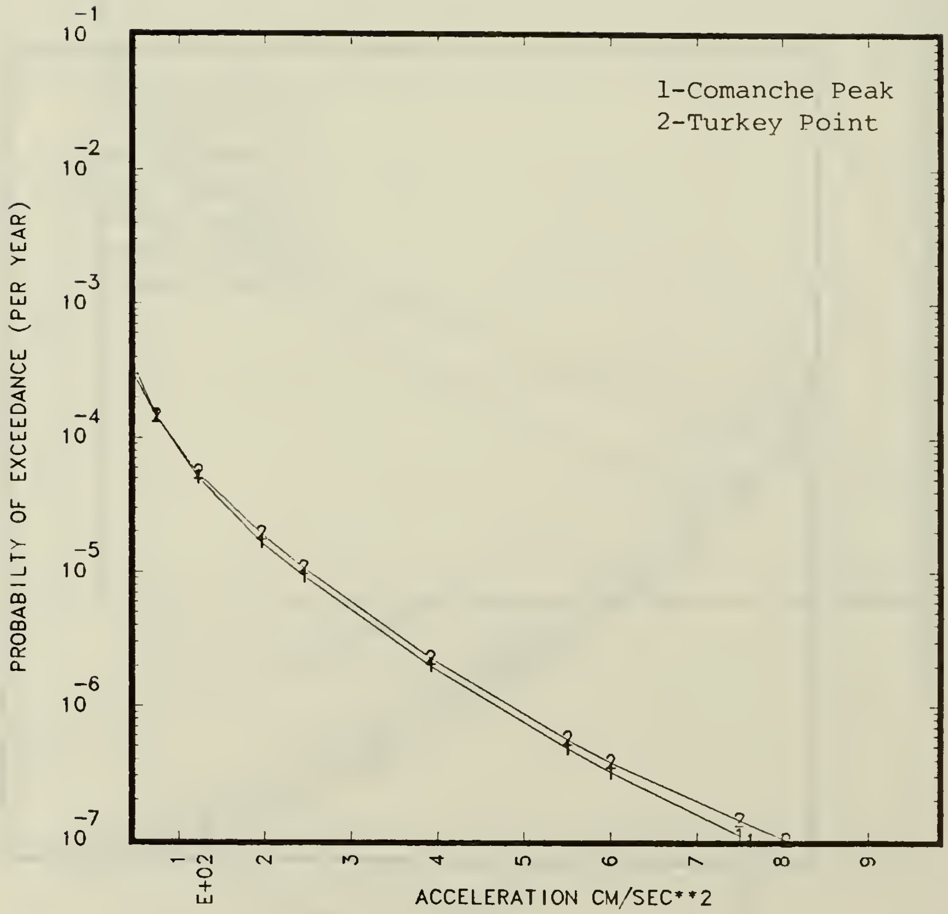

Figure 3.4.3 Comparison between the median CPHCs for the Comanche Peak and Turkey Point sites.

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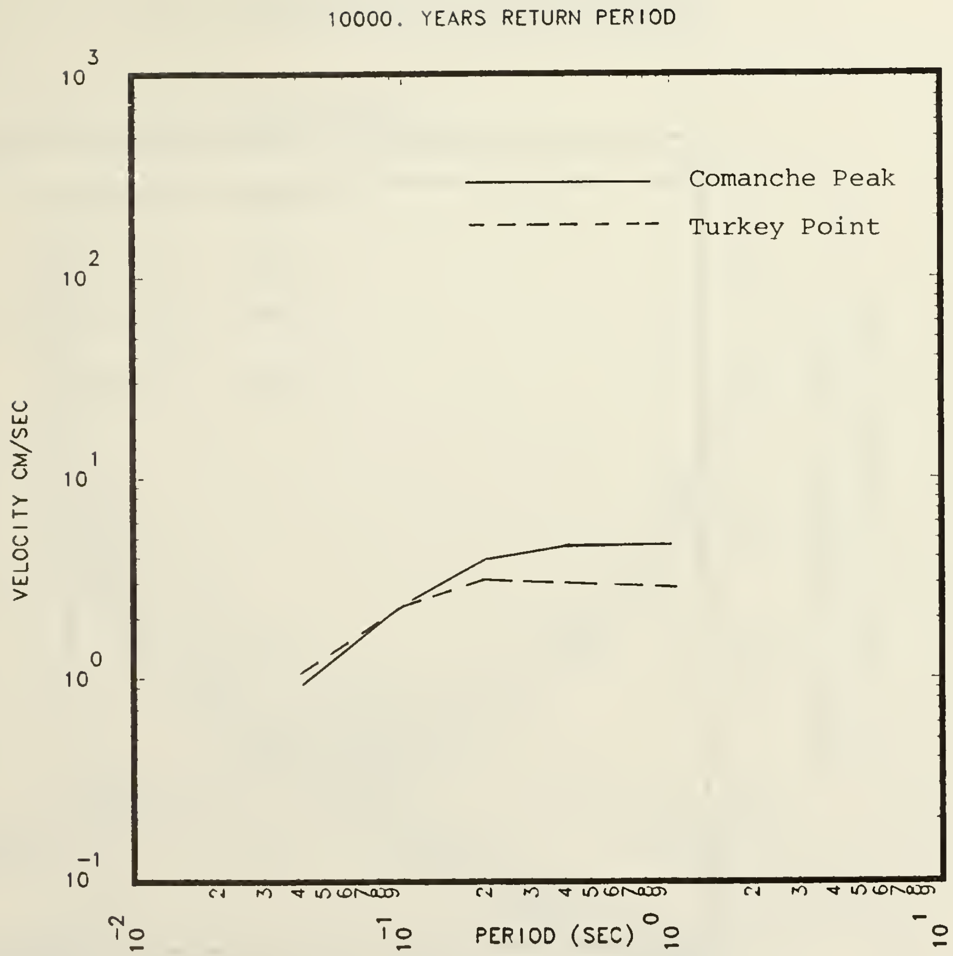

Figure 3.4.4 Comparison between the 10,000 year return period median CPUHS for the Comanche Peak and Turkey Point sites.

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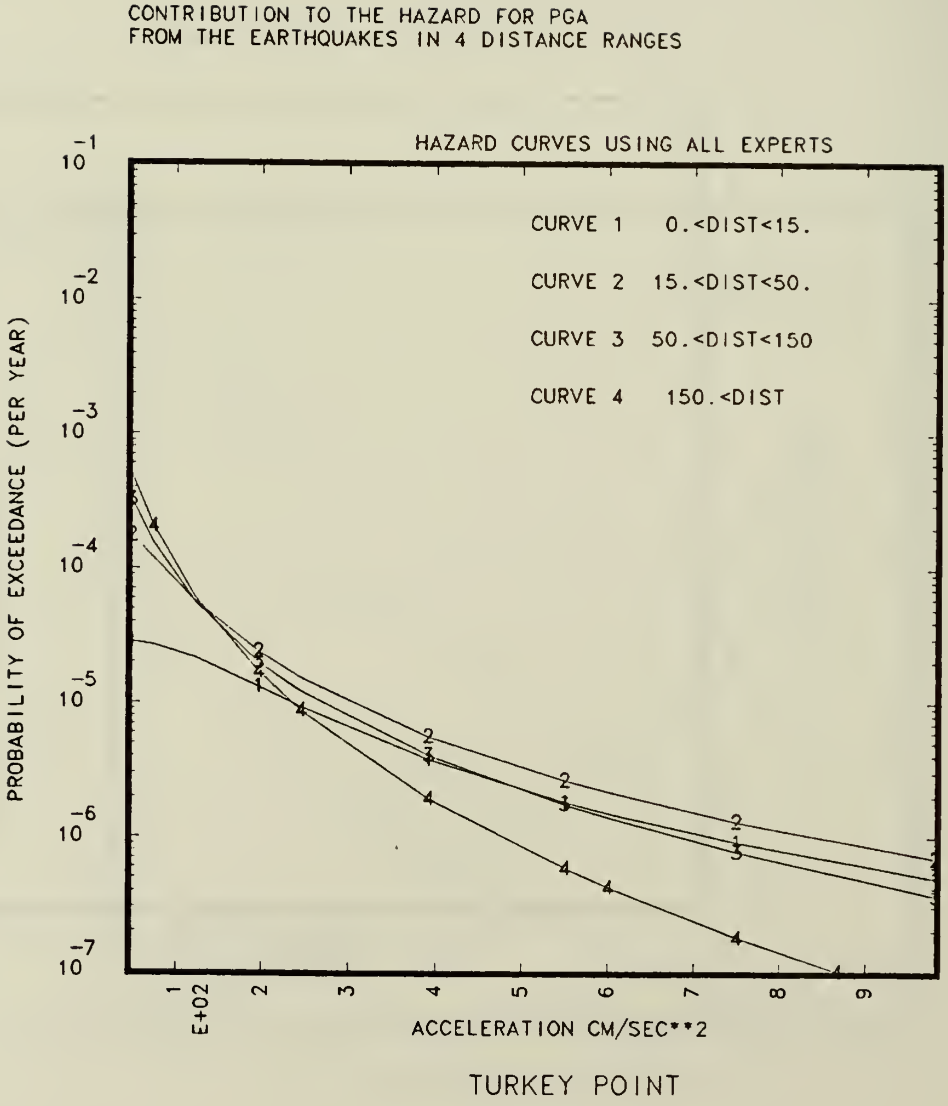

Figure 3.4.5 BEHCs which include only the contribution to the PGA hazard from earthquakes within the distance ranges indicated for the Turkey Point site.

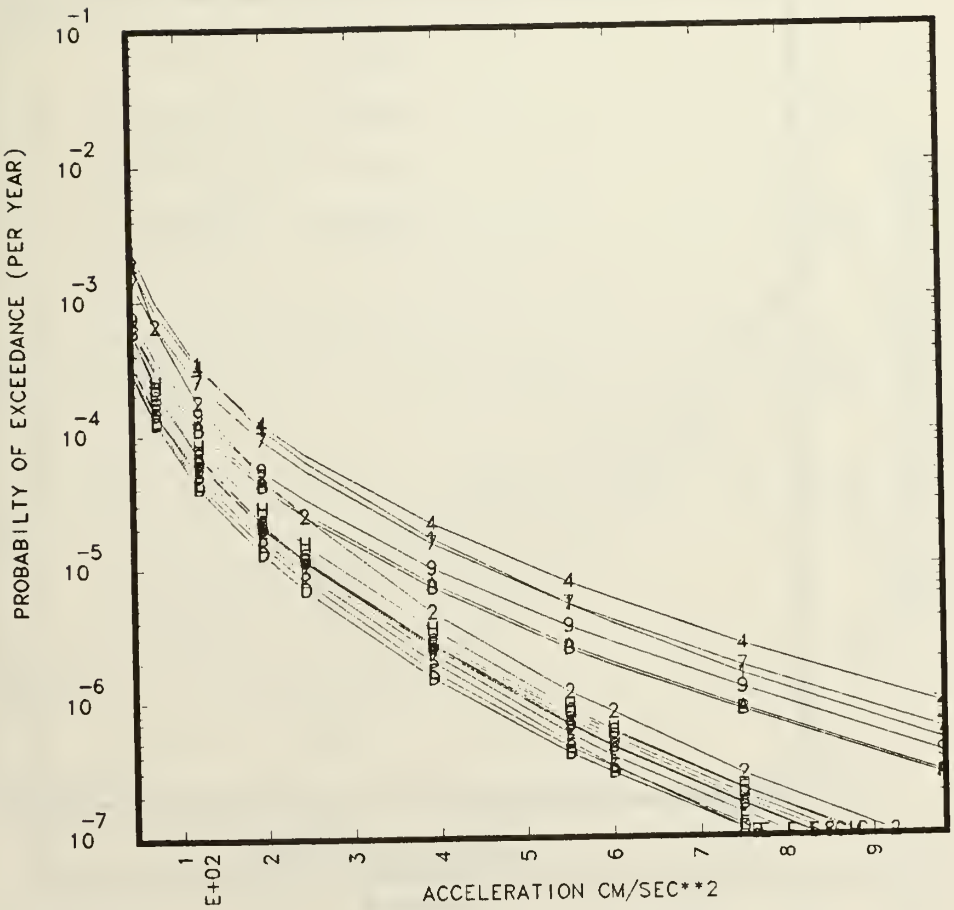

Figure 3.4.6 Median CPHCs for all the sites in Batch 4. The plot symbols for the sites are the same as given in Table 1.1.

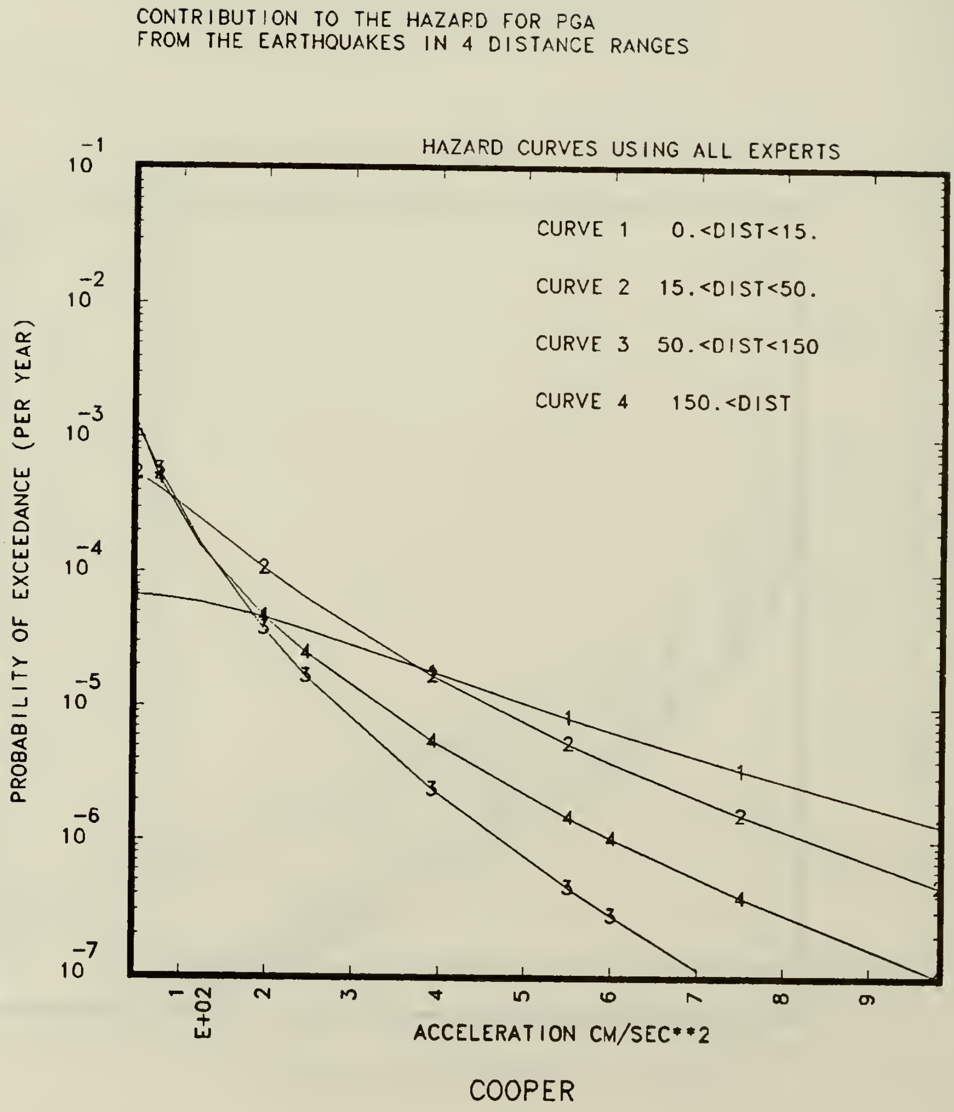

Figure 3.4.7 BEHCs which include only the contribution to the PGA hazard from earthquakes within the distance ranges indicated for the Cooper site.

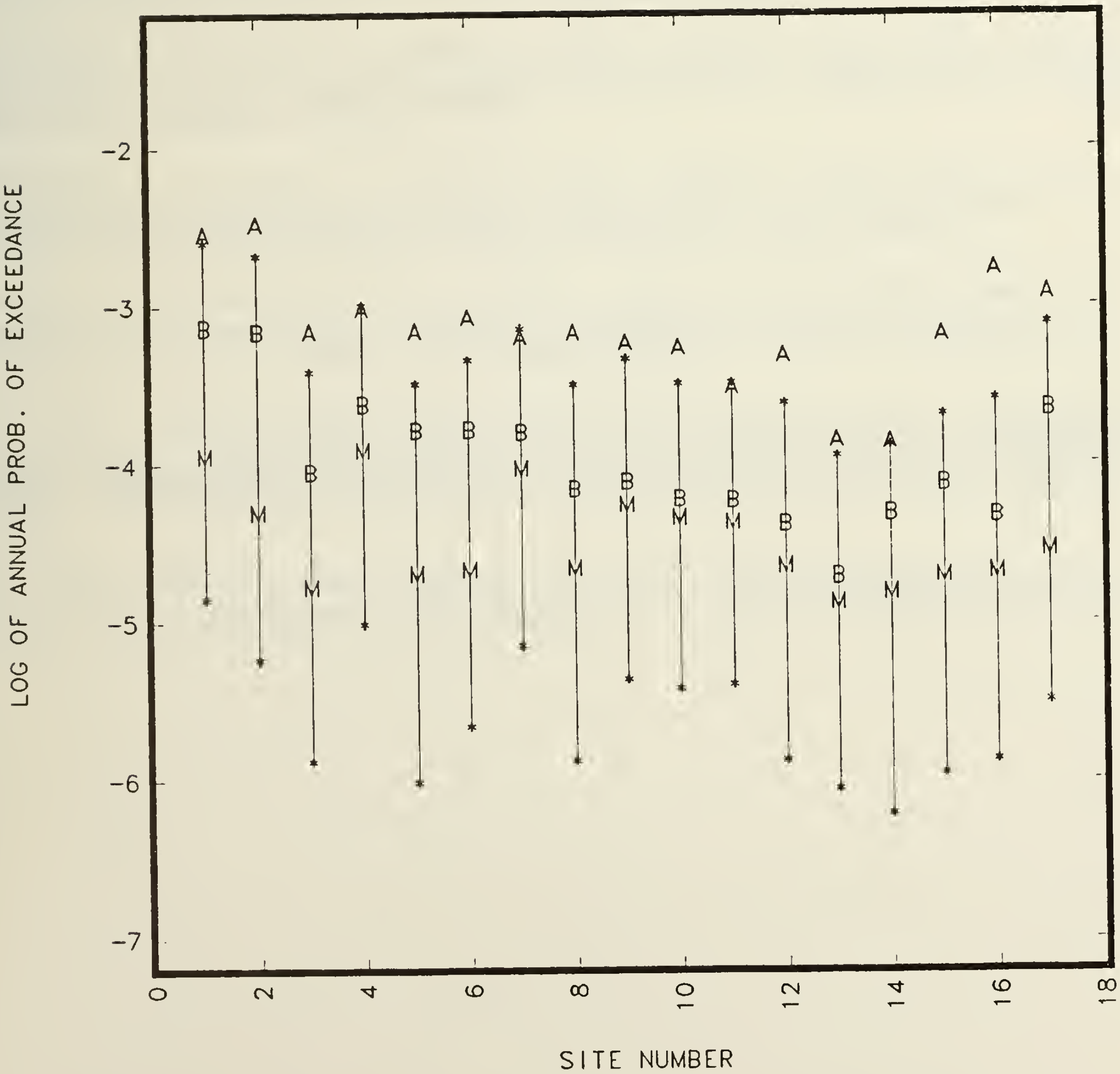

Figure 3.4.8 Median (M) probability of exceedance of 0.2g, best estimate (B), arithmetic mean (A), 15th and 85th percentiles (*) for the 17 sites of Batch 4.

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Appendix A

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Appendix B

Maps of Seismic Zonation of Each of the 11 S-Experts

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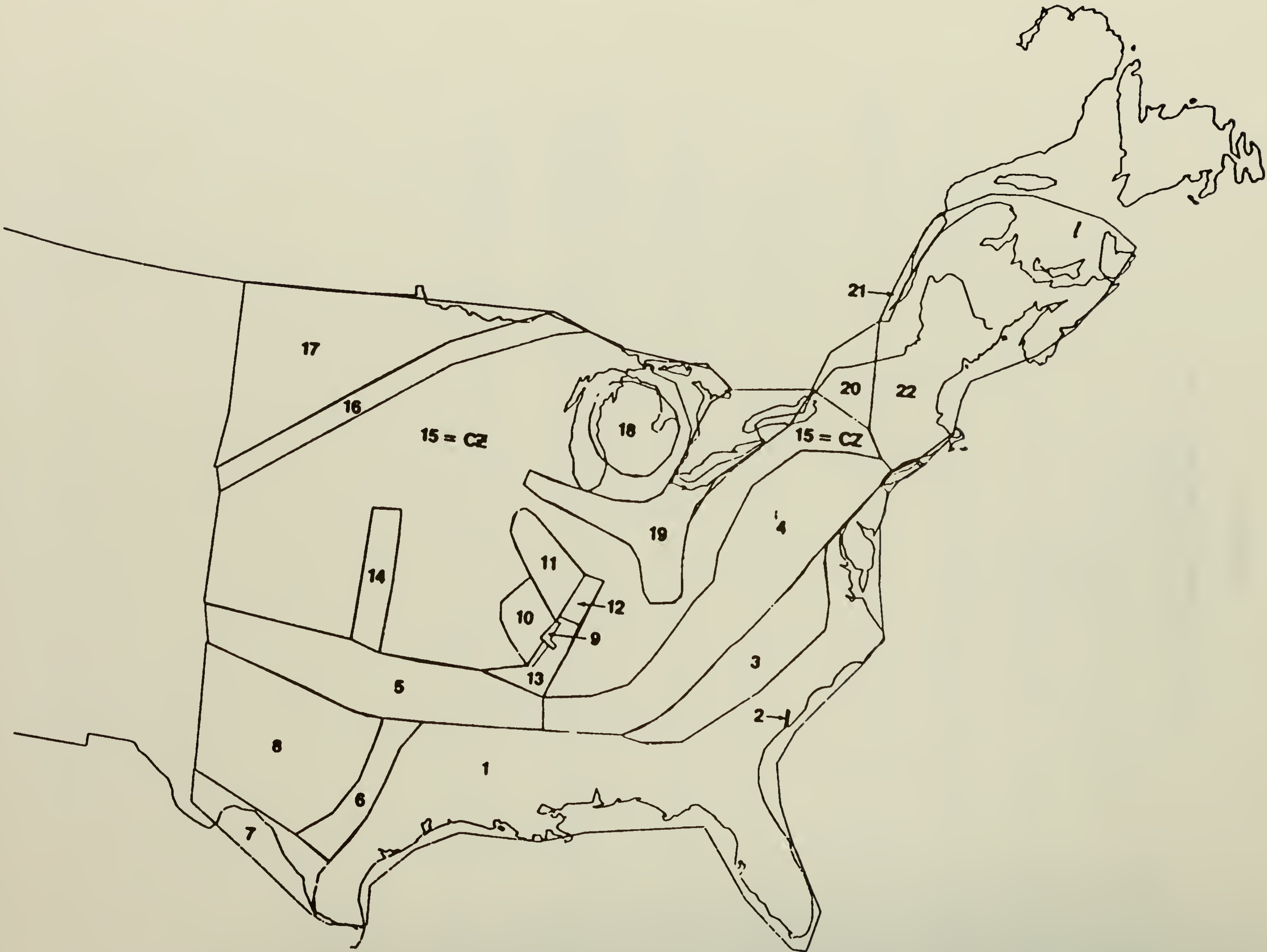

Figure B1.1 Seismic zonation base map for Expert 1.

Figure B1.2 Map of alternative seismic zonation to Expert 1's base map.

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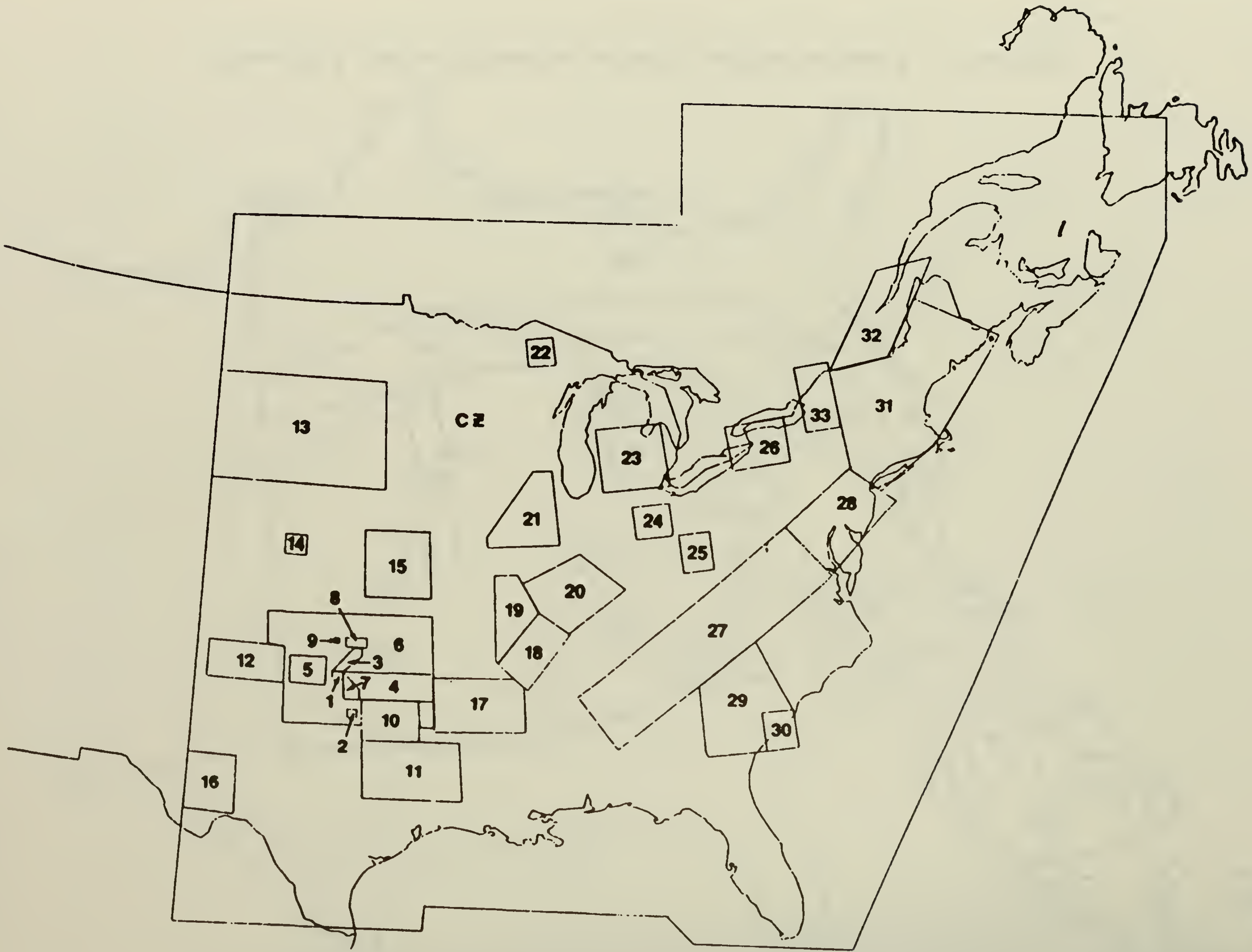

Figure B2.1 Seismic zonation base map for Expert 2.

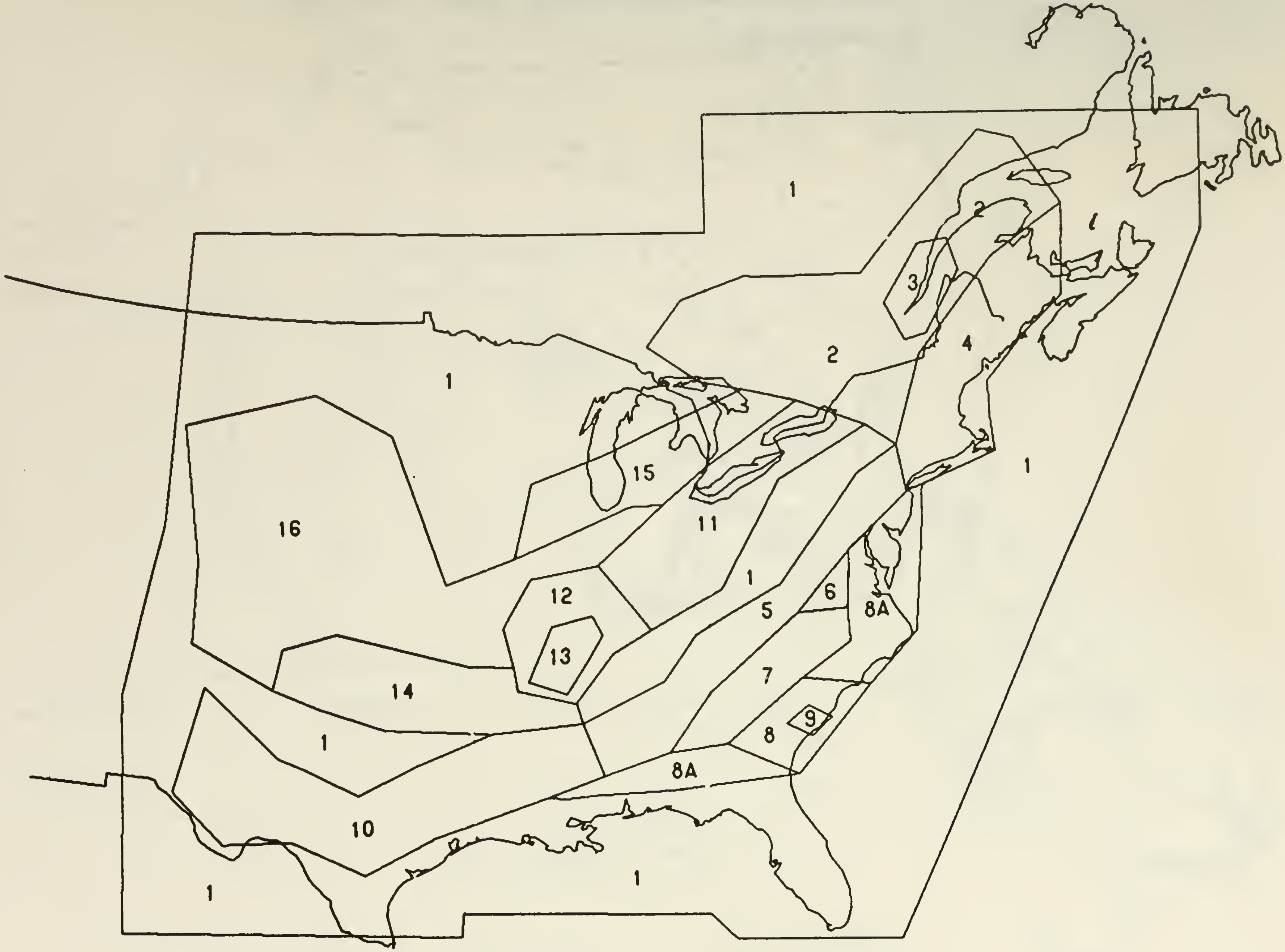

Figure B3.1 Seismic zonation base map for Expert 3.

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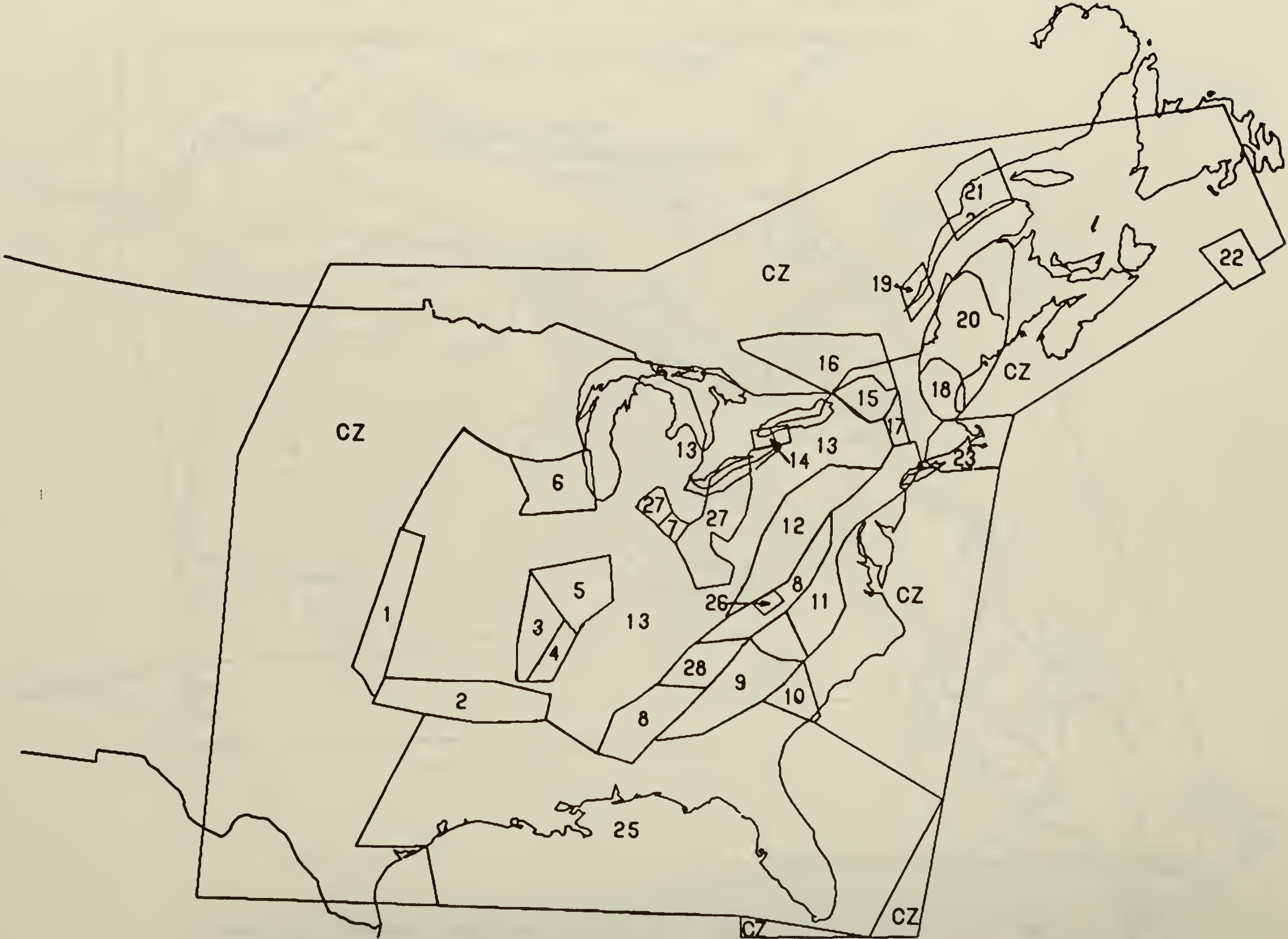

Figure B4.1 Seismic zonation base map for Expert 4.

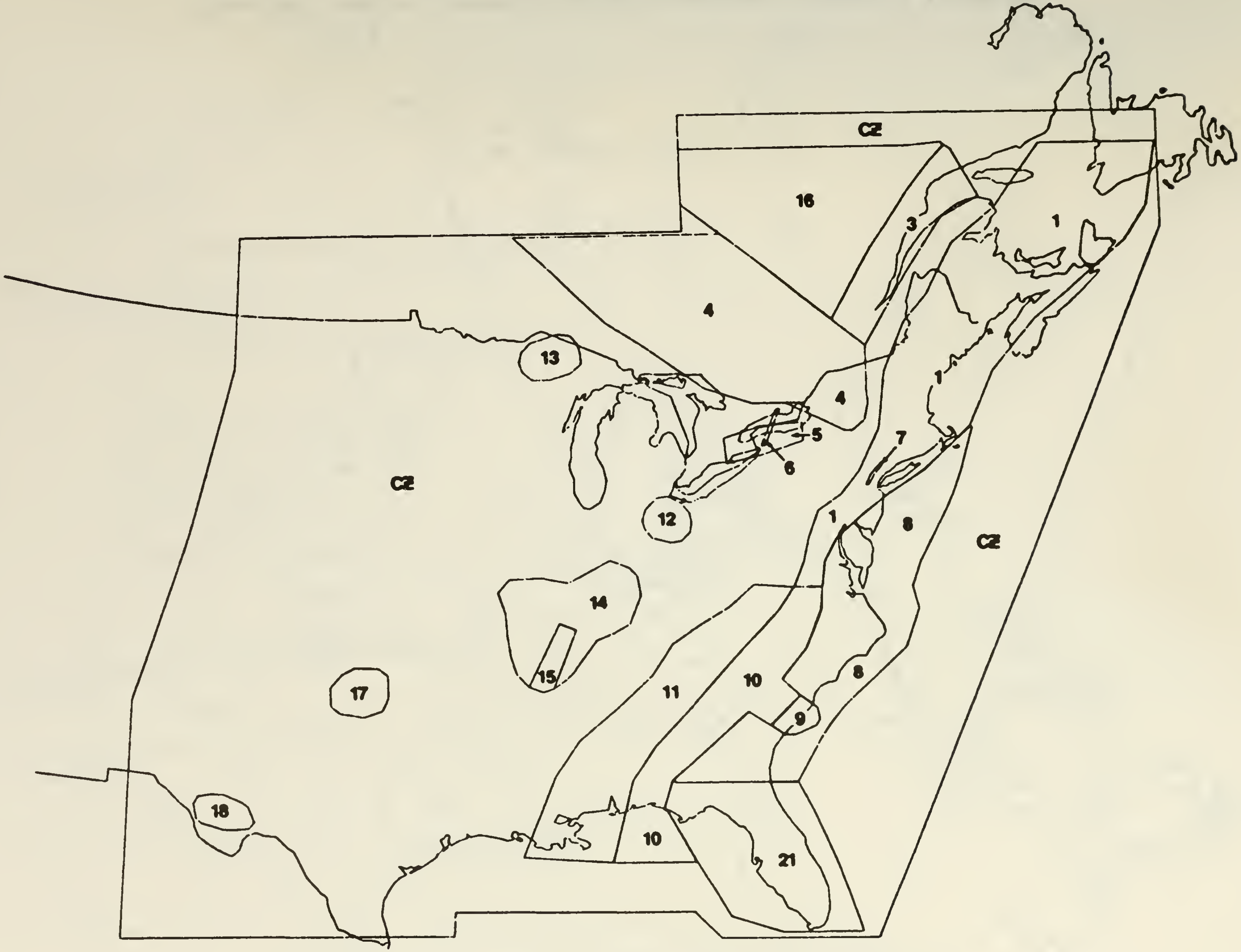

Figure B5.1 Seismic zonation base map for Expert 5

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Figure B5.2 Map of alternative seismic zonations to Expert 5's base map.

Figure B6.1 Seismic zonation base map for Expert 6

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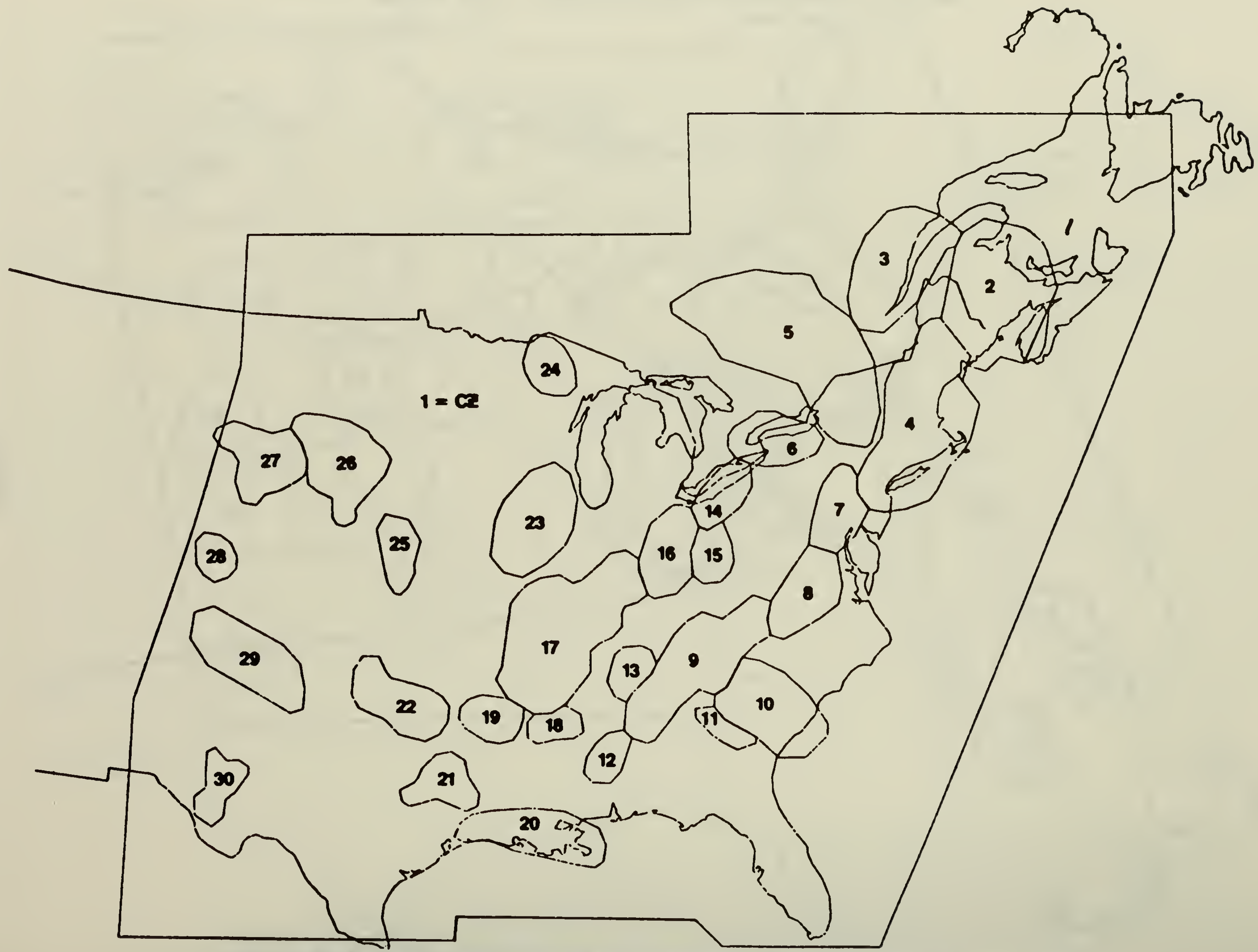

Figure B6.2 Seismic zonation map alternative 1 to Expert 6's base map.

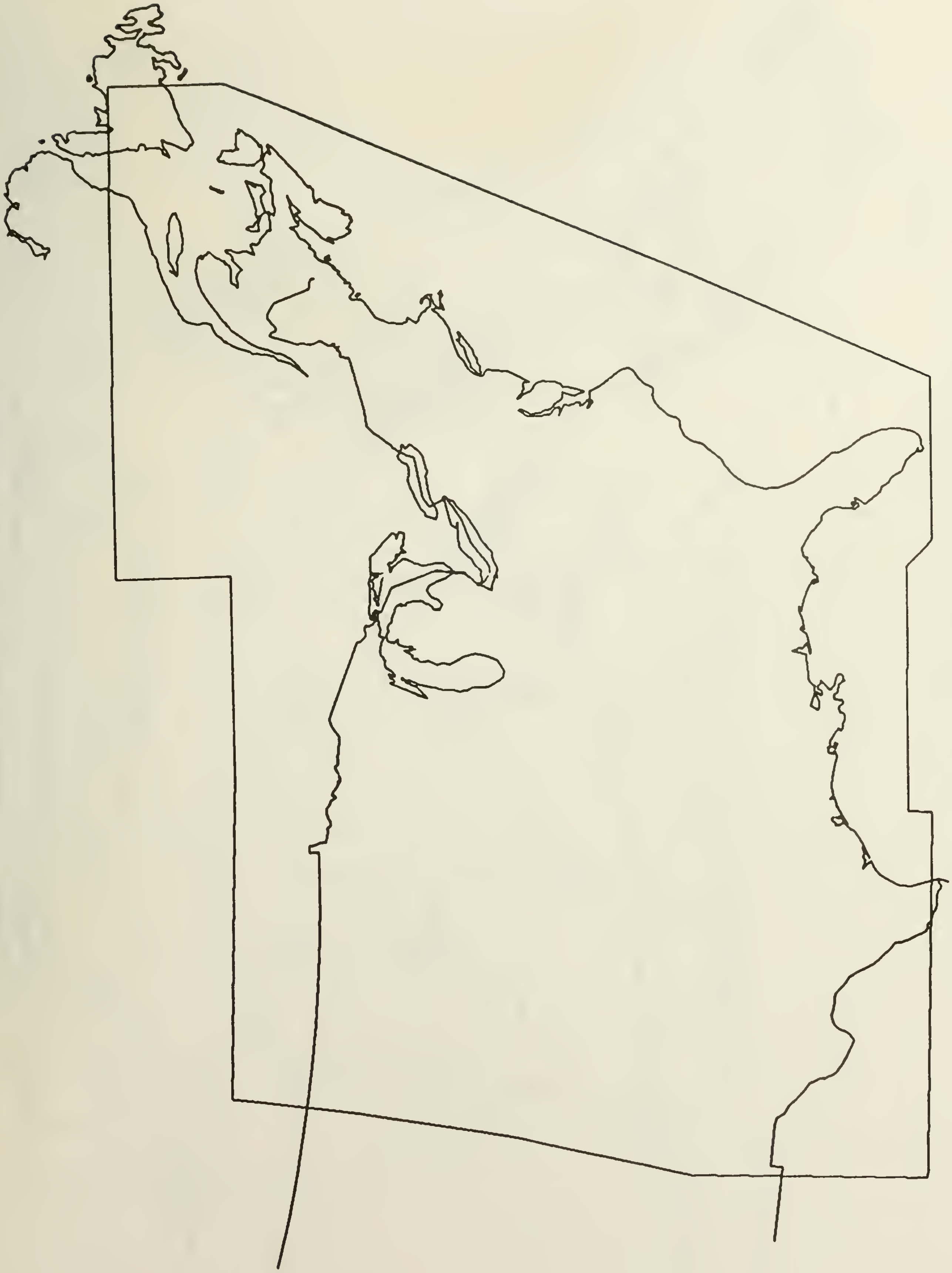

Figure B6.3 Seismic zonation map alternative 2 to Expert 6's base map.

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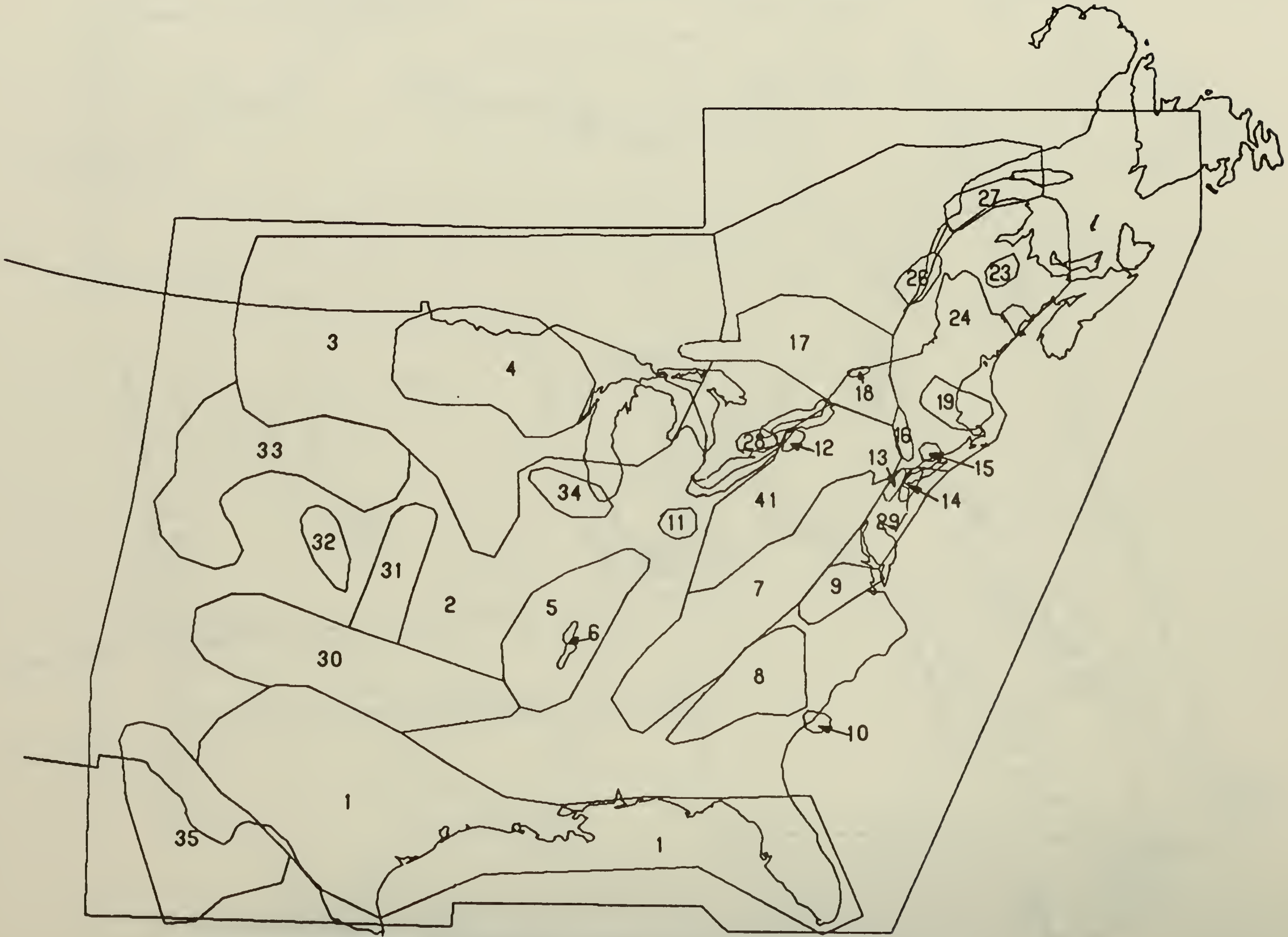

Figure 7.1 Seismic zonation base map for Expert 7.

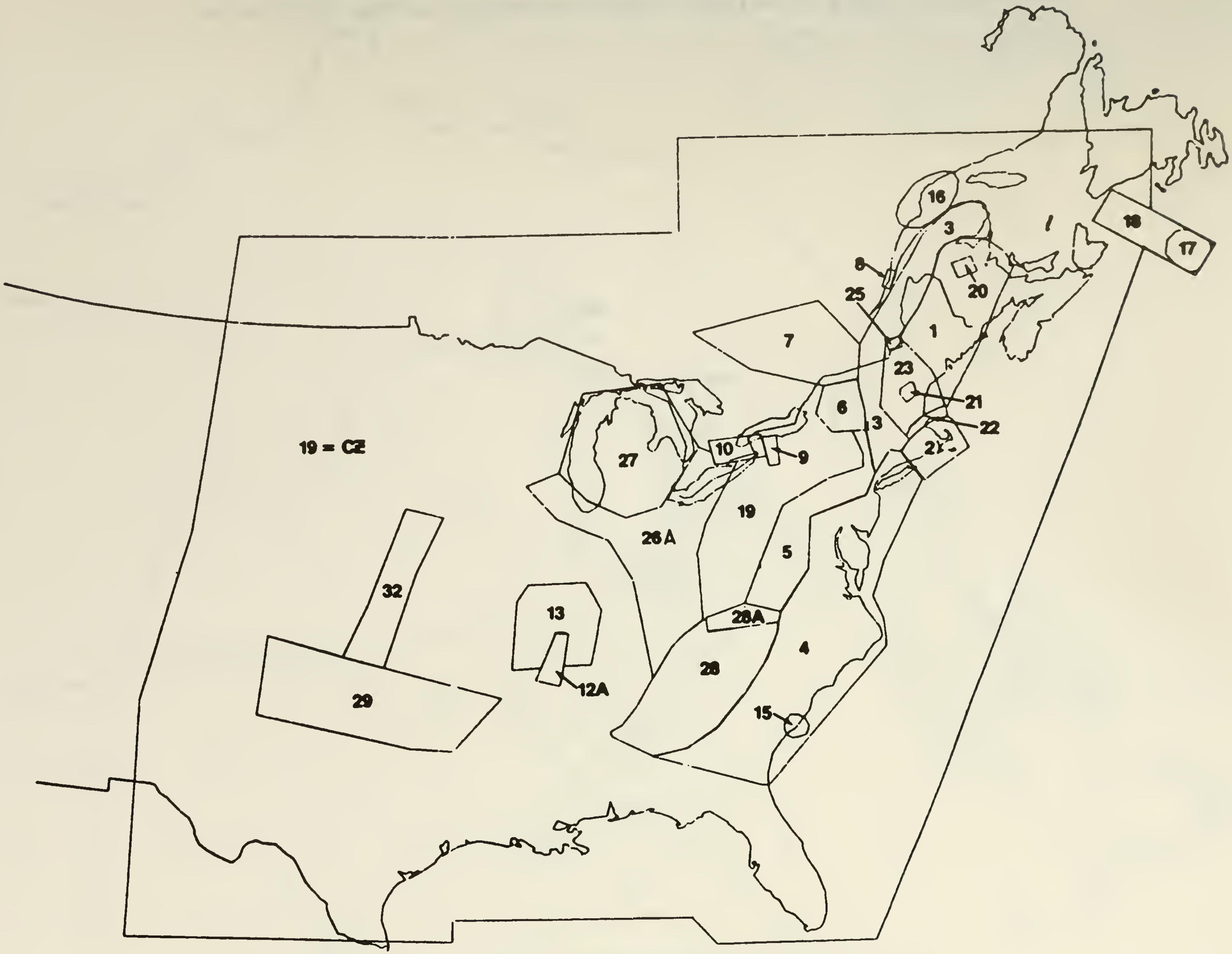

Figure B10.1 Seismic zonation base map for Expert 10.

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Figure B10.2 Map of alternative seismic zonations to Expert 10's base map.

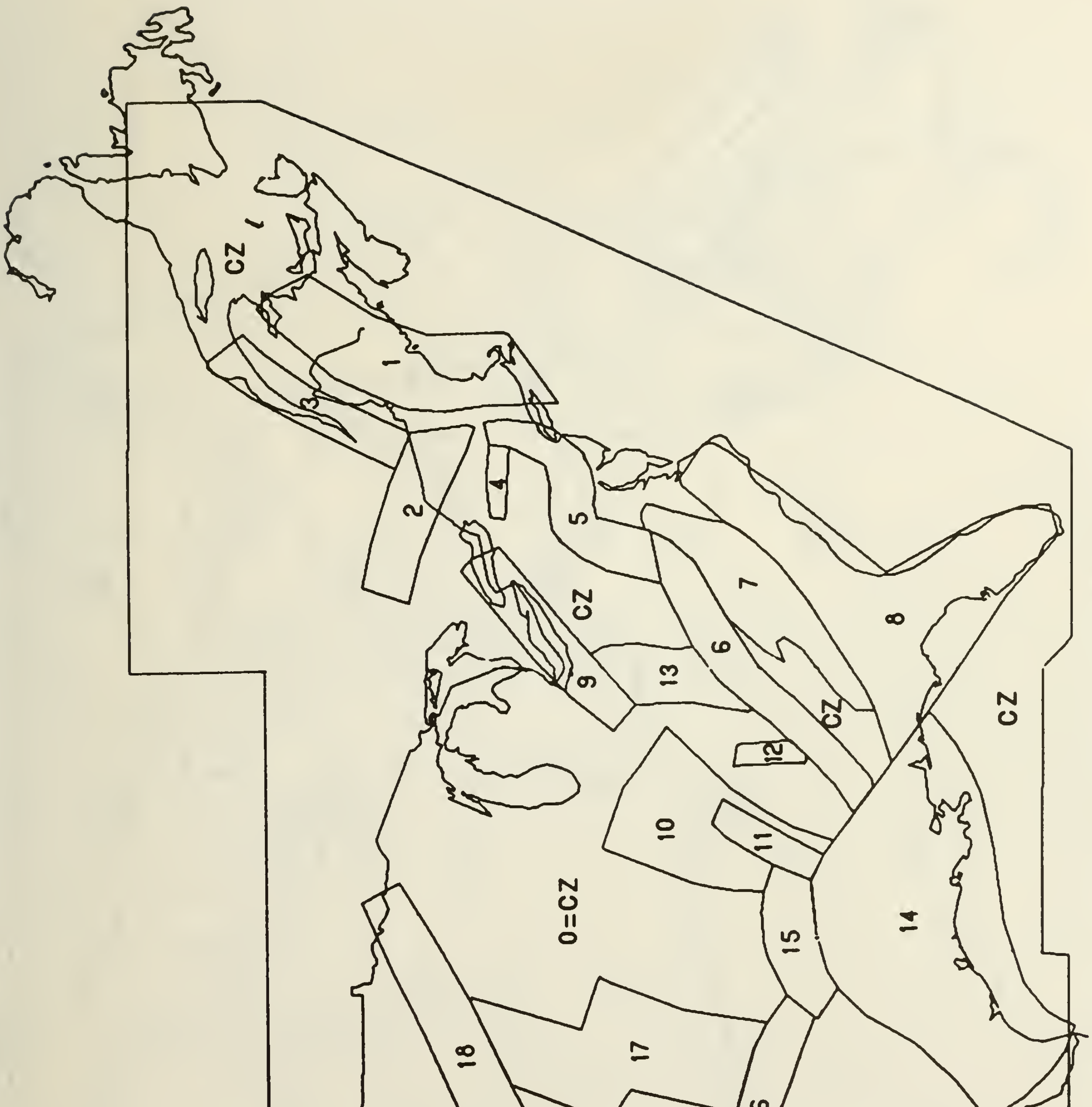

Figure B11.1 Seismic zonation base map for Expert 11.

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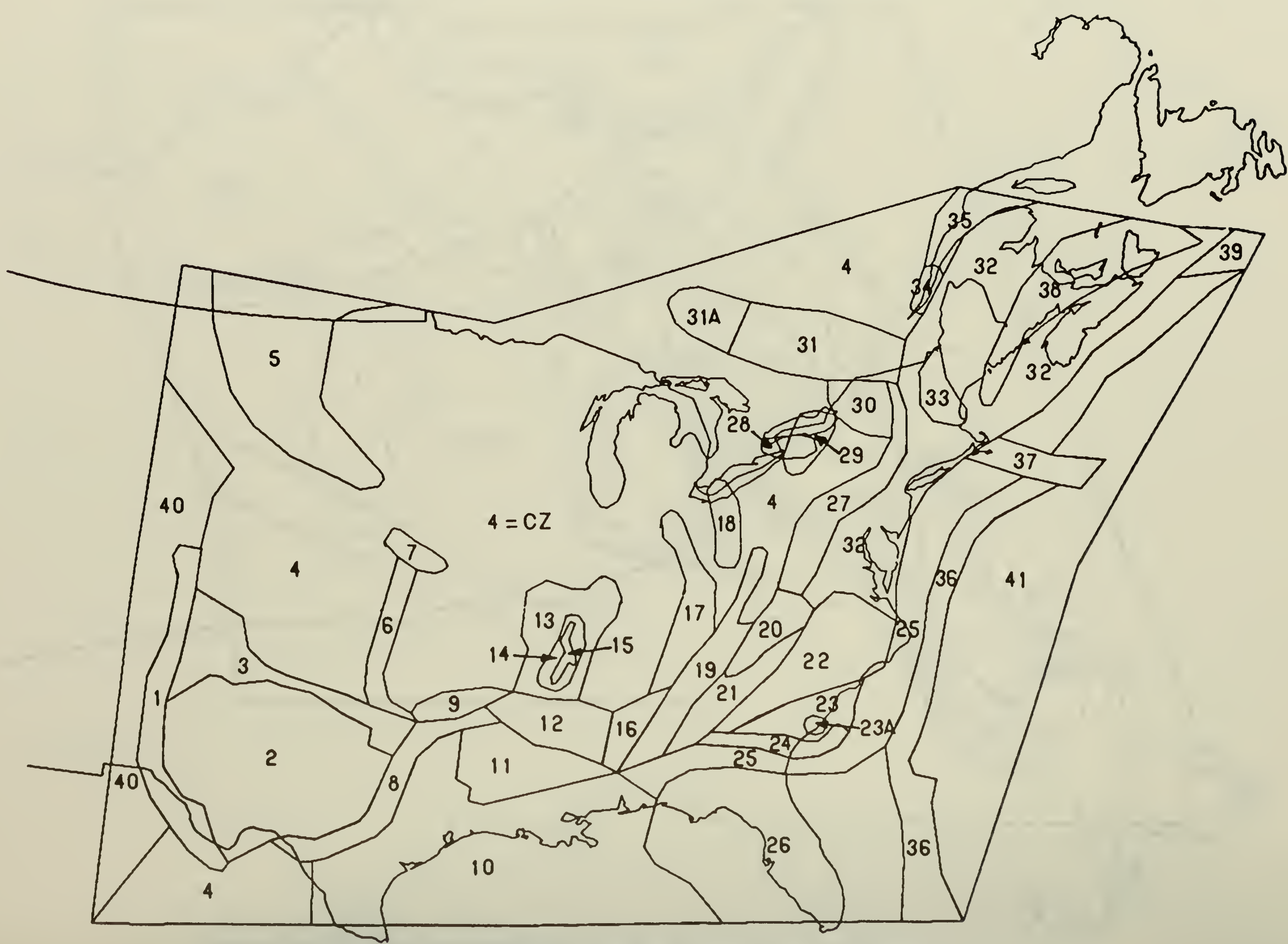

Figure B12.1 Seismic zonation base map for Expert 12.

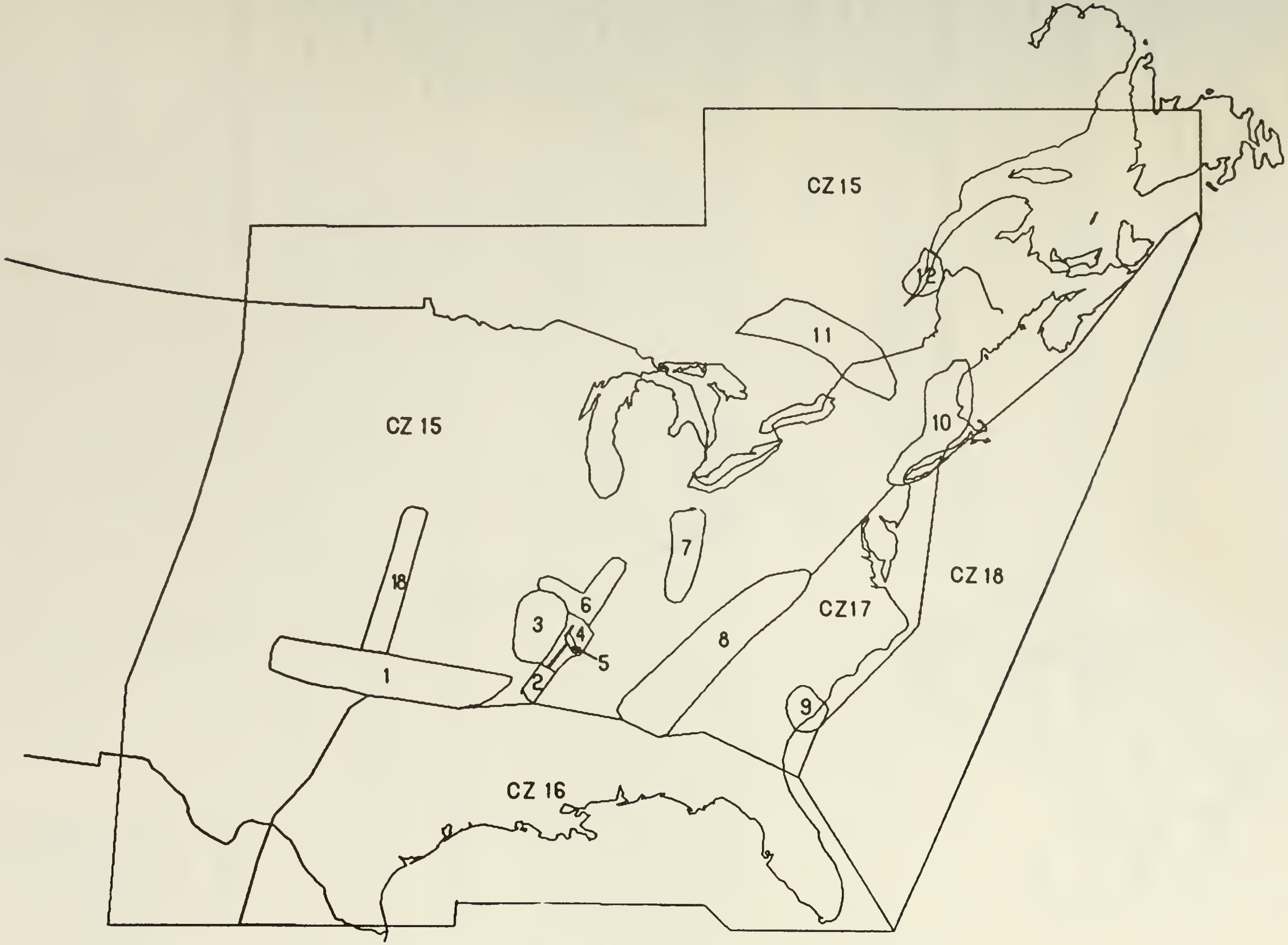

Figure B13.1 Seismic zonation base map for Expert 13.

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Figure B13.2 Map of alternative seismic zonations to Expert 13's base map.

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13. ABSTRACT (200 words or less)
The EUS Seismic Hazard Characterization Project (SHC) is the outgrowth of an earlier study performed as part of the U.S. Nuclear Regulatory Commission's (NRC) Systematic Evaluation Program (SEP). The objectives of the SHC were: (1) to develop a seismic hazard characterization methodology for the region east of the Rocky Mountains (EUS), and (2) the application of the methodology to 69 site locations, some of them with several local soil conditions. The method developed uses expert opinions to obtain the input to the analyses. An important aspect of the elicitation of the expert opinion process was the holding of two feedback meetings with all the experts in order to finalize the methodology and the input data bases. The hazard estimates are reported in terms of peak ground acceleration (PGA) and 5% damping velocity response spectra (PSV).

A total of eight volumes make up this report which contains a thorough description of the methodology, the expert opinion's elicitation process, the input data base as well as a discussion, comparison and summary volume (Volume VI).

Consistent with previous analyses, this study finds that there are large uncertainties associated with the estimates of seismic hazard in the EUS, and it identifies the ground motion modeling as the prime contributor to those uncertainties.

The data bases and software are made available to the NRC and to the public uses through the National Energy Software Center (Argonne, Illinois).

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